THE MODEL ENGINEER

Edited by

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SMOKE RINGS

The Club Spirit

MY recent "Smoke Ring" on this subject has brought me a number of letters from club officials and members who testify to the warmth of the club spirit which can be engendered by the use of the right methods. Here, for example, is a letter from Mr. A. B. Carrington, of the Romford Model Engineering Club, which speaks for itself. He writes: "May I take the liberty of butting into your 'Smoke Rings' in order to endorse the opinions voiced by you in your item 'Fostering the Club Spirit'? I was, for many years, a 'lone hand,' but, by mere accident, I met a member of the Romford Model Engineering Club, and, more against my will than otherwise, I joined that Club. I look back to the day I did so with the thought that it was the best thing I ever did. I anticipated meeting a very learned crew of expert modellers, who would look down on me as an interloper, and I expected, to say the least, a very 'cold shouldering.' But I did not get it. Far from it. The 'old hands' took me by the hand, made me one of the circle, and made me feel thoroughly at home from the first minute. And now, as one of the Romford boys, I can, and do, advise anybody who is in any way interested in model engineering to join us, knowing that, in doing so, I shall, later on, be thanked for so doing. There is a total lack of 'cliqueism,' if I may coin a word. The spirit of comradeship and the manifest desire to help does away with any shyness the new member may feel, and, in particular, the junior members, of which we have quite a number, are brought into discussions and encouraged to voice their opinions. Furthermore, we have our workshop well on the way to completion now, and the older members have been well to the fore in putting things in order, which, in itself, will prove what I have said about the unselfishness of this section of the Club. I would earnestly advise anyone who lives in the neighbourhood of Romford to look in on us on any of our meeting nights. They will find a warm welcome awaiting them, and they will feel at home from the moment they get inside the door. We meet on the first and third Thursdays in each month, and, during the summer, there are track days and interesting outings. I am afraid I have trespassed on your valuable space to a large extent, but I felt so sorry for your correspondent who is experiencing so much trouble, and I feel sure that, if he takes the advice you offer, he will eventually overcome his difficulties." The Romford Club meets at the Red Triangle Club, and has the advantage of a well-laid circular outdoor track for the use of its members. I hope that any "lone hands" who may still exist in that district will take advantage of Mr. Carrington's invitation, and drop in to see what is doing on the next meeting night.

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Model Engineering Up Top

SOME time ago, I referred to a model engineer who enjoyed the distinction of being "farthest South" amongst our readers. I have recently had another claim submitted from a reader in South America who suggests he must be the "highest up." I used to think my most elevated reader was one who is in charge of a power station on the top of a mountain in Cyprus, but, if I remember rightly, his altitude is a mere 4,000 feet. My present correspondent writes from La Paz, in Bolivia, where he does his model making at a height of over 10,000 feet above sea level. Mr. Theodore K. Pepper writes: "May I, as the 'tallest' of the model engineer brotherhood, wish you and the 'M.E.' a prosperous New Year, and many of them? (I live at 3,600 metres above sea level.) I am at present engaged on the construction of a model of a 1,000-ton steamer—the *Ollanta* we have at Lake Titicaca, the highest navigable lake in the world, 3,812 metres above sea level. The ship was built by Earl's, of Hull; it is a twin-screw job of 2,200 h.p. The whole of the hull was put together with bolts and nuts, at Hull; the girders and plates numbered, and then taken apart again to be shipped by sea and rail to Lake

Titicaca, where it was finally put together and finished. The model of the *Ollanta* has taken me, so far, one and a half years, and I have, now, only finished the hull and machinery, having still all the superstructures to make. My workshop, at present, consists of an Atlas 9 in. lathe, oxy-acetylene welding set, and a few hand-tools. It is practically impossible to get any materials suitable for model making here, so that I have to make do with whatever I can lay my hands on. Mail-day from Europe, which brings the 'M.E.,' is always expected eagerly." I never read a letter of this kind without feeling a great admiration for the enthusiasm and perseverance of those who do their model making under such isolated conditions, in regard to the supply of tools and materials. I hope their weekly copy of the "M.E." at least makes them feel that they are in contact with some thousands of other kindred workers, and that they can derive inspiration and encouragement from its pages. The "spirit of the 'M.E.'" is undoubtedly a very real and very widespread thing.

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A Model of the Port of London

THE rapidly-growing use of models for purposes of commercial demonstration is instanced by a very impressive model which has just been constructed to the order of the Port of London Authority. It is a mechanically-operated model of a section of the Thames and the Docks systems of the Port of London. The model has been produced to the specification of Sir David Owen, the Authority's General Manager, and embraces original features which enable it to be housed in the minimum of space consistent with the scale employed. Built on a horizontal plane, the model depicts the River Thames from Tower Bridge to Barking Reach, and includes the five large Docks systems—*i.e.*, the London and St. Katharine Docks, India and Millwall Docks, Surrey Commercial Docks, Royal Victoria and Albert and King George V Docks, and the Docks, Jetty, and Passenger Landing Stage at Tilbury. The area involved comprises 14 miles of the river, while the Docks cover a total area of 4,247 acres, of which 722 are water area. About one-third of the model is visible at a time, the whole consisting of 13 hinged sections constructed on an endless band, which is rotated by an electric motor. The mechanism embodies principles of construction which have not hitherto been used for model work. The model is built on a scale of 150 feet to 1 inch, and the accurate reproduction, in miniature, of the many types of warehouses, transit and storage sheds, cranage and other equipment, together with the large number of vessels, tugs, and other craft, represents an enormous amount of work by the makers, Messrs. A. D. Services. An elaborate switchboard enables the operator to illuminate numerous points of interest on the model, including dock entrances, warehouses, sheds where specific commodities are housed, railway sidings, etc. In addition, other switches illuminate, on an inset map of the world, the countries of origin of the important commodities imported into the Port of London. The model may be seen at the offices of the P.L.A. on Tower Hill.

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A Sevenoaks Exhibition

THE second Annual Exhibition, organised by the Sevenoaks Model Engineering Society, is to be held this year at the Cornwall Hall, Sevenoaks, on April 8th and 9th. Last year, the show was held in conjunction with the local Rotary Club, but the Society are running their Exhibition, on the present occasion, entirely independently. It will be opened on April 8th, at 3 o'clock, by the Chairman of the Urban District Council. Co-operation, by way of loan of interesting exhibits, would be welcomed by the Hon. Secretary, Mr. F. C. Waghorn, 71, Lennard Road, Dunton Green, Kent.

* * *

A Miniature Electric Motor

A READER has kindly sent me a cutting from a Marseilles newspaper, in which is described what purports to be the smallest working model electric motor in the world. It has been made by M. Georges Rabattu, and its size is indicated by the fact that it would require eight of such motors to cover an ordinary postage stamp. It weighs 0.42 grammes, and contains thirty parts. The armature is 5.2 mm. diameter, and the commutator 1.7 mm. The coils are wound with wire 0.05 of a millimetre thick, and the length of the armature spindle is 6.5 mm. between the bearings. The writer of the article mentions an American motor so small that it would stand on the finger-nail of the maker, and a motor made by a French watch-maker, weighing only 9 grammes, but points out that M. Rabattu has produced something far more marvellous as a piece of miniature craftsmanship. To quote the article: "'But this microscopic model—does it work?' we inquired, incredulous. M. Georges Rabattu smiled. He took a little 2-volt battery from his pocket and applied the wires to the terminals of the motor. Miracle! A light buzzing sound, like a fly in flight, rose in the silence. The motor is at full speed—nearly 2,000 revolutions per minute! We shook the hand of the patient constructor, justly proud of his work. This achievement, truly curious, is well worth placing on record."

* * *

Northern Heights Gala Day

MODEL aeroplane enthusiasts should make a note of Sunday, June 19th, the date fixed for the 6th Annual Gala Day organised by the Northern Heights Model Flying Club. It will be held, as usual, at the Great West Aerodrome, and the flying of models will take place from 11 a.m. till dusk. A first-class programme of events is being arranged.

Percival Marshall

A Working Model of a "Garrett" Overtype Steam Engine

By S. A. CANE

DURING 1924 I was working, for several weeks, at the Wembley Exhibition, signwriting in the Engineering Section ; while there, Messrs. Garrett, of Leiston, installed an overtype steam engine, 270 h.p., and, of course, I was very fascinated, seeing it erected and being put under steam. I had forgotten all about this, when I happened to see a picture of it in a magazine, about 1933, and thought I would like to make a model of it. I wrote to Messrs. Garrett & Sons, Engineers, Leiston, asking them if they would let me have some pictures of the engine, which they very kindly did. I was then all set for a very busy time, getting out the drawings, which had to be modified, from time to time.

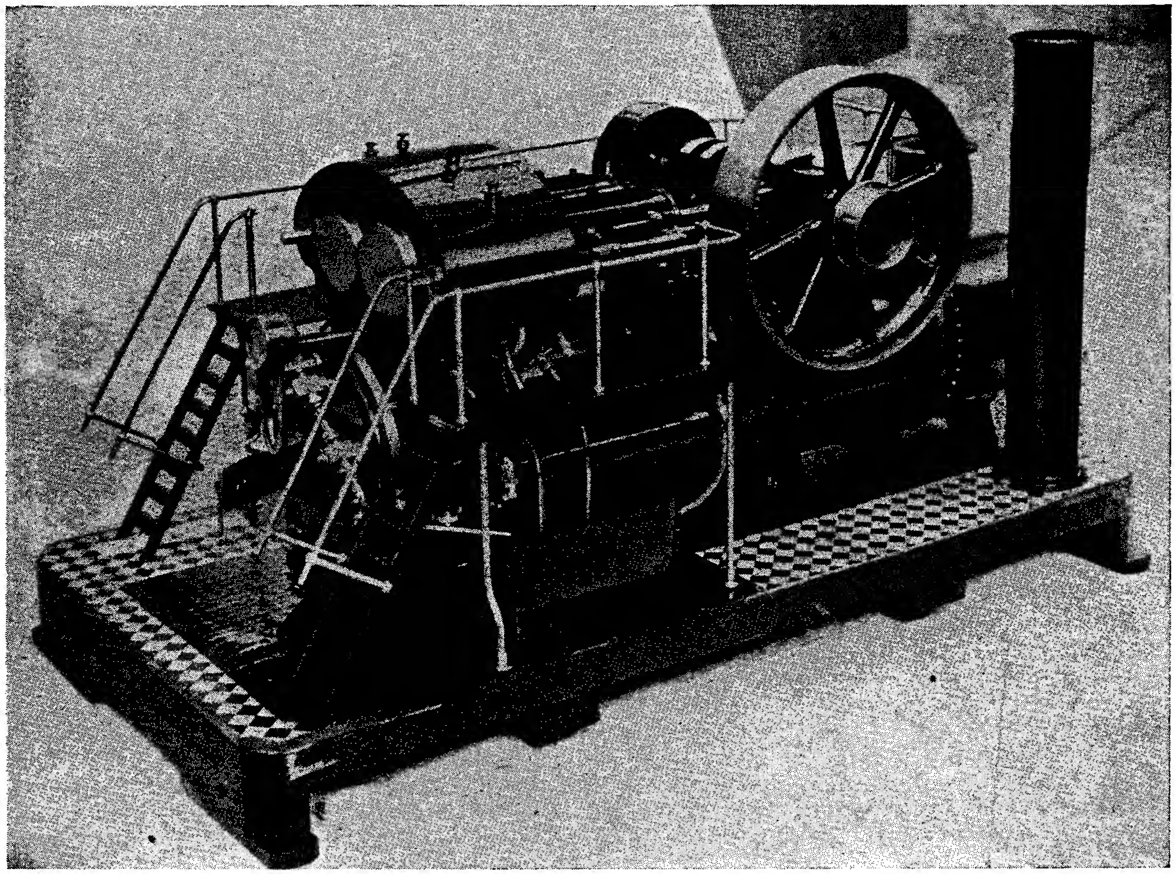
Next came the making of the boiler—a piece of copper tube, 3″ x 15″ long ; the ends were brazed in, with 3/16″ stay-rod connecting the two ends. Three ⅜″ tubes were then silver-soldered into the underside of the boiler, and the other ends into an inverted "T" fitting. The boiler was tested to 200 lb., and is fired by gas.

Then I made the outer boiler-case, a piece of barrel 5″ diameter x 15″. The smokebox is 3″ long, with a copper ring riveted on inside, and then fixed by screws into boiler barrel, making a total length of 18″. The casing is lined with asbestos.

I next made the wood patterns for the flywheel crankpit, and cylinders, and had the flywheel and crankpit cast in iron and the cylinders in gunmetal. The cylinder-bore is 1″ x 1½″ stroke. Ordinary slide-valves are fitted. The stop-valve, on the left-hand side of the engine, just below the cylinder, admits steam to a turret on top of cylinders, below the lagging sheet. The exhaust steam passes direct into the heater, the hand-pump passing the water through a tube in middle of heater, then through firebox to front end of boiler. The pump, driven off crankshaft, is built up from steel and brass ; two 5/32″ bronze balls are in the valve-boxes. This pump keeps the water well up the gauge-glass.

The two trunk-guides were made from a 4″ length of 1¼″ copper tube, with the two steel guide-bars screwed on to the inside.

The crankpit is bolted on top of the boiler, supported by steel bearing-plates riveted to each side of the boiler. Split brasses and oil-boxes are



Mr. S. A. Cane's working model of a "Garrett" Overtype Steam Engine. (A silver medal winner at the 1937 "M.E." Exhibition).

fitted to the three main bearings. The flywheel was bored on the faceplate, and the rim turned and spokes cleaned up with a file, in the usual way.

The crossheads were built up of five pieces of steel, and brazed together. They were then connected to piston-rods with cotters. Then came some "donkey" work, making the two connecting-rods. A piece of steel, 1" × ⅜", and 5" long, was roughed out with hacksaw and file, and turned down to 5/16". The big-ends have split brasses.

The eccentric-straps are cut out of 3/16" × 1½" brass bar, bored and shaped. All small levers and knuckle-joints are cut from solid steel.

The next job was making the water-gauges and cylinder drains. I found that it is much easier to make kinks in the tubing, rather than beautiful bends. Trade in small taps and lost screws went up with a jump during this job. The galleries were made from ⅛" steel plate. The chequered work was done with a hacksaw on a block similar to a carpenter's mitre-block. All standards were turned from ¼" round steel, and the handrails, ⅛" round rod. The two ladders were made up in steel and brass, and brazed. The black and white tiling, on floor, is hand-painted.

Then came the first steam-up on the kitchen-table. The hand-pump put more water on the table, and on the floor, than into the boiler. That was a very wet evening! The leaks were, eventually, made good, and all worked beautifully, excepting the pressure-gauge, which refused to register more than 1 lb. of steam, although the table did a cakewalk when the throttle was fully open. I have had it under steam quite a dozen times, and have had friends to see it. It has not failed once. When the throttle is just open slightly, it "ticks over" beautifully, which shows the slide-valves are set correctly.

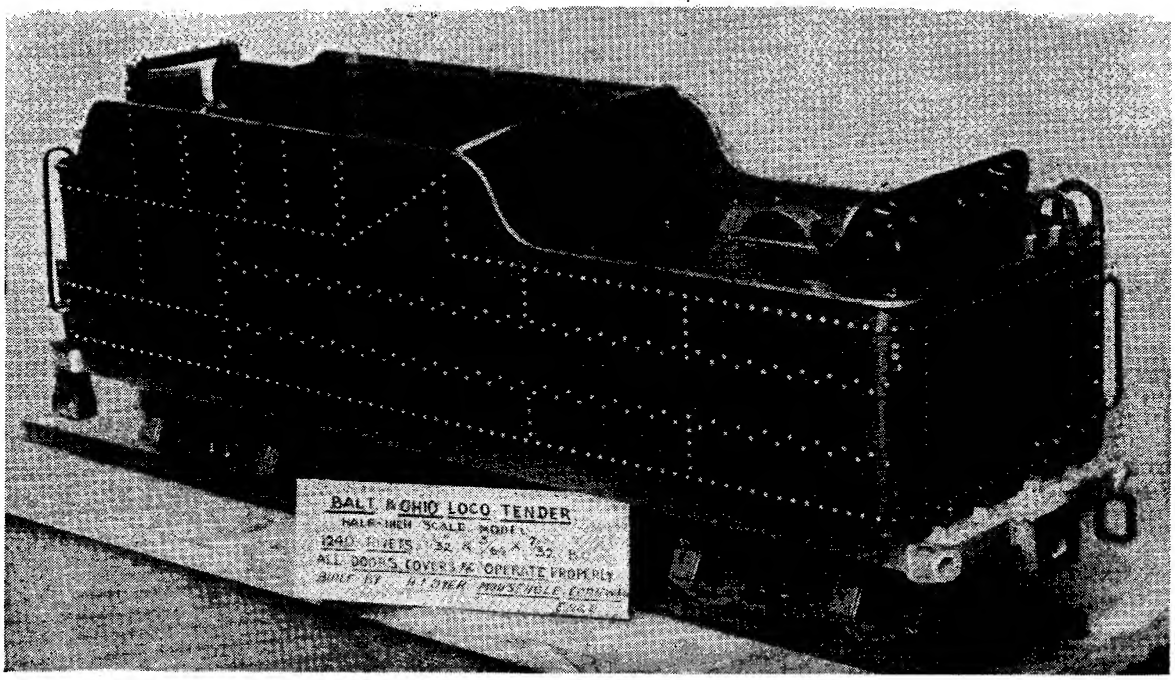
This type of engine is used for electric lighting, flour-mills, saw-mills, stonework, and waterworks.

This model was awarded a silver medal at the 1937 "M.E." Exhibition.

A Thousand Rivets and More

HERE is an example of patient model engineering work, carried out to a customer's order, by Mr. Herbert J. Dyer, of Mousehole, Penzance. It is a tender for a half-inch scale model of a Baltimore and Ohio locomotive, and contains no less than 1,240 rivets. Mr. Dyer tells us that this job occupied 380 hours. He says it "seems a lot of hours for just a tank on wheels, but there's nothing there that depends on solder. Every part is riveted, and sweated after, but there's no solder among the rivet-heads. Just think what a grand lot of machining I could have done in the time. It meant spacing, popping, drilling, filing of rag, inserting rivets, cutting to length, holding up, heading over, and snapping. There were quite a lot which were headed up outside, and these had to conform with the "made" heads of those put in from outside. Machine work may be slow, but it shows something for one's time, and that's more than riveting does when it is *riveting*."

The spacing and alignment of the rivets, in this job, will bear the closest inspection. Mr. Dyer sends us a list of the number of rivets in each part of the tender, from which we note that, on the two sides, there are over 700, on the back end 62, and on the front end, including the steps and angle hold-down lugs, 69. Not the least difficult problem was the insertion of some of the rivets in the awkward places.



An ½-in. scale B. and O. Locomotive tender, constructed with over 1,000 rivets by Mr. H. J. Dyer.

SHOPS, SHED AND ROAD

A Column of Live Steam

By " L.B.S.C."

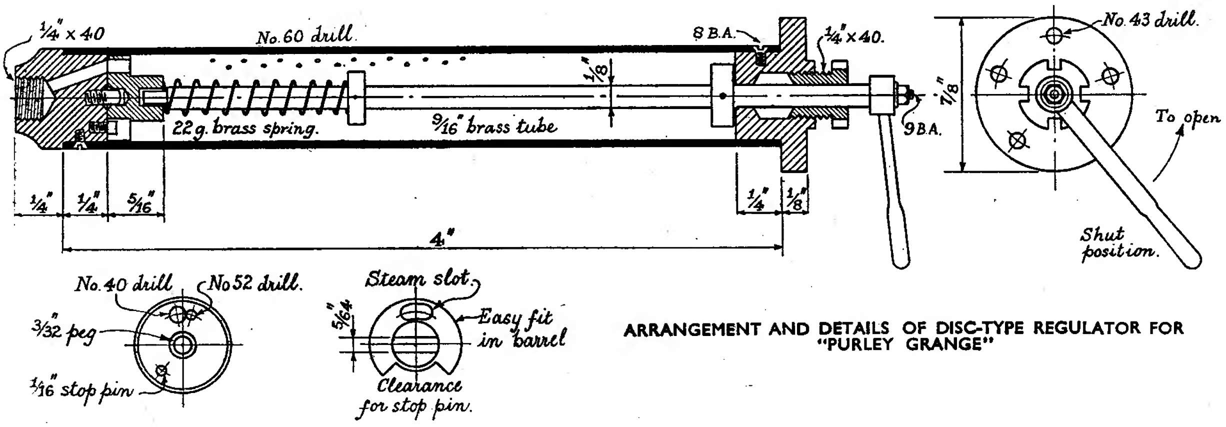
" Not To-day, Thank You ! "

From letters received in answer to my offer *re* old-type Cudworth 2-4-0, L.M.S. 0-6-0 standard tank, and 0-6-0 Great Western saddle tank, all in 3½" gauge, it is evident that not enough of our fraternity are interested in these locomotives to warrant a full description with sketches, so we'll let them pass. However, some of the letters offered a few helpful suggestions for future notes, always provided we are able to carry on. Several brothers suggested describing a L.M.S. tank engine of larger type, such as the 2-6-4, of which a large number are now running. For their benefit I would point out that I have already schemed out a general arrangement and full detail sketches for this engine ; and blueprints, made from tracings off my original sketches, can be obtained from some of our advertisers. I believe Kennion stocks them. As the working parts of this engine are very similar to the " Dyak," the notes on the construction of that engine can be used in conjunction with the prints mentioned above, so nobody should have any trouble in building a L.M.S. 2-6-4 tank, if they so desire. The prints are full size for 2½" gauge.

I note the L.M.S. " Silver Jubilee " (three-cylinder 5X) is still called for, so I will finish my partly-completed sketch and include it, with necessary notes and details, all being well. Also, our old " hardy annual," the L.N.E. " Pacific." I thought there were already enough drawings and descriptions of these engines to supply the needs of everybody who wanted to build one, and a few more besides ; but no! Says one reader, " Let's have a real ' live steamer,' with three cylinders, the two-to-one gear plus monkey-glands, and your fast-steaming combustion-chambered boiler." Others are hankering after a 1938 edition of " Fayette." That, too, is already done, as far as getting out the general arrangement is concerned. She is a 4-6-4 with four cylinders, a combination of L.M.S. and G.W. practice, and was evolved for the benefit of those of our friends who wanted something a little larger than actual British practice, but not so ponderous as the " super-heavyweights " designed by friend Josslin. More about this shortly, circumstances permitting.

Ever Taken a Seidlitz Powder ?

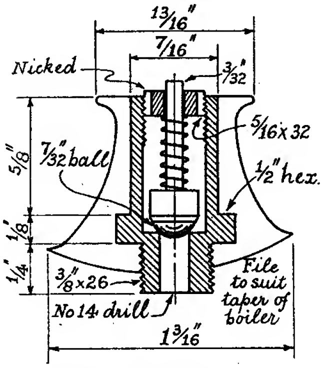
You'll be wondering why on earth I asked that question, and what the merry dickens these old-fashioned concoctions have to do with locomotive work—eh? Oh, no! you don't drop the contents into the boiler, shake it up, and proceed without any need of lighting the fire! We just call on the Seidlitz powder as a parallel, that's all. I've received several direct letters on the subject of the Drummond " Paddleboxes " and their valve-gear, but nobody has hit on what I think was the trouble, except an old engineman friend who knows some of the antics your humble servant gets up to, with little valve-gears. Meantime, the note from Mr. Willoughby, in February 17th issue, was interesting, inasmuch as his fact was correct, but his reasoning faulty. In endeavouring to flog the poor old "lead" horse once more, he overlooked the fact that if you chop ⅛" off



ARRANGEMENT AND DETAILS OF DISC-TYPE REGULATOR FOR "PURLEY GRANGE"

the steam-laps of a valve, and don't alter the eccentrics, *the cut-off point is not the same, but later,* in every position of the lever, as the valve has the extra 1/8" to travel before closing the port. Consequently, the engine will use more steam ; and if the boiler has no reserve of power (the Connor boilers were on the small side) in normal working, it will have to be forced, to make the extra steam, and, naturally, will burn more coal. The sluggishness is easily explained ; if there is more steam entering the cylinders, there is more to get rid of. If the eccentrics had been advanced to give the extra lead, instead of chopping bits off the laps, there would have been a vastly different tale to tell. How do I know? Well, I try things out!

Two of my " quads " have link-motion ; and, just as an interesting experiment, I set one of them to the recently-recommended link-motion setting, *viz.,* no lead and 90 per cent. cut-off in full gear, and tried her on the air-pump. She " ticked " all right, you could make her crawl around, but she hadn't any " life " ; was as dead as ditchwater, with no acceleration worth writing home about, heavy exhaust beats, and I had to pump like Old Nick to keep her going. Then I altered her to my pet setting. Oh, what a difference in the morning! With a good lead and early cut-off, she made just twice the number of revolutions to one stroke of the



Safety-valve and casing

pump, and was as lively as a kitten. Experiment teaches!

Now for the Seidlitz powder. There are two portions of this—one in a blue paper, and one in a white. If you take them both, according to directions, the combined effects of the two do the job the powder is supposed to do ; but if you only take one, it not only won't do you any good, but you'll get pains in the tummy. It is just the same with a valve-gear, only there are more than two parts to contend with. It isn't a scrap of good using long laps, or big leads, unless the other part of the gear is arranged to suit. In the case of the " Paddleboxes," the engineer took the contents of the blue paper all right, but only tasted the white ; and when, in a manner of speaking, things began to go wrong inside, he tried a fresh bottle of medicine altogether and cattled up the whole contract, as he never " got well."

If you look on page 62 of Colburn's " Locomotive Engineering," you'll see a drawing of old Bro. Churchwarden's pet valve, with the lap equal to the width of the steam port ; and, as the book was published in 1864, *his* ideas haven't advanced much! There is a drawing of old Ben Connor's eight-footer in the same book, and students of valve-gear will be interested to note that the back-gear eccentric-rods are an inch shorter than the fore-gear rods—that Seidlitz powder again! Seriously, though, it is useless for good folk to point out that my own valve-gears don't conform to " the book," for they are not intended to do so ; what they *are* intended for, is to make the engines pull and go, on the smallest possible amount of steam ; and no unprejudiced party can deny that they always do it.

" Purley Grange " (*Contd.*)—Boiler Fittings—Regulator

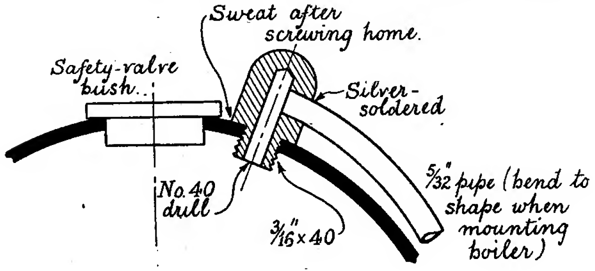
As most of the boiler fittings are similar to those on the " Southern Maid " and have been described in full detail, there is no need to go through the lot again, but only to illustrate, with notes, those which are peculiar to this special engine. The first-mentioned include turret and whistle-valve, blower-valve and pipe, steam- and water-gauges, and firehole door. The superheater is made from 1/4" tube, otherwise it is the same, and so are the headers, flange and union.

The regulator is of the disc-in-a-tube pattern, operated by a regular G.W. pull-up handle. The barrel is a 4" length of 9/16" brass treblet tube, squared off at the ends, drilled with about thirty No. 60 holes as shown, and furnished at the back end with a gland and flange for attaching to the back-head bush. This is turned from 7/8" round brass rod, or from a casting, to sizes given in sketch. The throttle block is a 1/2" length of 9/16" bronze rod, or a piece turned from a cast stick. One end is turned to fit the barrel, faced truly, centred, drilled and tapped for pivot, the rod being held in three-jaw ; it is then reversed, and the other end turned to shape, drilled, and tapped for steam-pipe. Then drill the steam-ports, and fit the stop-pin and peg. The valve is a 5/16" length of 9/16" rod of different grade from the throttle block ; *drawn* gunmetal is suitable, and I have also had success with duralumin and similar alloys as used for automobile pistons. It must be turned an easy fit in the tube. Drill the hole for peg, and countersink it ; then reverse in chuck, and turn boss. Drill and file steam-ports and stop-pin slot, then cut the slot in the boss for regulator-rod. If you haven't a miller or planer, and cannot machine the slot, saw it with a fine hacksaw and finish with a key-cutter's warding file.

Many good folk have trouble in getting the faces steam-tight. No need for it at all. Just rub them on a big flat dead-smooth file laid on the bench, then put a piece of fine emery-cloth, business side up, on the lathe bed or saddle, and rub them on that, giving a twisting motion as you rub. The resulting matt surfaces will go together quite steam-tight, and the scratches hold the lubricant, forming a seal. The regulator-rod is a 4 1/4" length of 1/8" rustless steel or German silver. 5/32" of one end is turned down and screwed 9 B.A., and the next 3/32" filed square. The other end is flattened, to fit the slot in the valve easily. A 3/8" collar is pinned exactly 3 1/4" from flatted end, and another about 1 1/4" as a spring thrust. The spring is made from 22 gauge hard brass wire wound around the rod and cut off to length.

To assemble, fit gland-piece to barrel, and secure with an 8 B.A. countersunk brass screw. Oil valve-face with cylinder oil ; insert rod in barrel, leaving the flattened end just showing ; place spring on it, and hold the valve assembly so that flattened end enters slot. Then carefully press home and secure throttle block with 9 B.A. countersunk screw. Pack gland with graphited yarn, and fit handle as sketch.

Drill and tap a $\frac{3}{8}$" by 40 hole in smokebox tubeplate, $\frac{1}{2}$" from top ; then screw a piece of $\frac{1}{4}$" copper tube, threaded both ends, and $9\frac{1}{8}$" long, into the throttle block. Insert regulator in boiler, with a 1/64" Hallite washer between flange and bush, and secure with 8 B.A. roundhead screws. The holes in the bush should, of course, be drilled and tapped previously, using the gland-piece itself as jig. Be careful to have the steam-collecting holes on top of the barrel. At the smokebox end, screw in a $\frac{5}{8}$" flange having a $\frac{3}{8}$" boss, screwed 40 threads and tapped $\frac{1}{4}$" same pitch, which will lock the pipe solid when screwed home with a little plumber's jointing on the threads. See " Southern Maid " sketches for illustration of a similar fitting. The steam-pipe should



Top feed fitting.

be bent, before fitting regulator, to come in the centre of the hole in smokebox tubeplate. The superheater element can now be made of $\frac{1}{4}$" copper tube, as per " Southern Maid " notes, and attached to flange by three 3/32" screws.

Safety-valve and Casing

Pop-valves are not used on Great Western engines, one reason being that they usually run with a high water-level, and the safety-valves, being on the taper barrel and, therefore, close to the water, would tend to lift it every time the engine blew off. Little " Purley Grange " has also a plain valve, made from a bit of $\frac{1}{2}$" hex. rod, 1" long ; $\frac{5}{8}$" of this is reduced to 7/16" diameter, drilled right through No. 14, and opened out, bottomed to 11/16" depth, and tapped 5/16" by 32. Reverse in chuck, turn down and screw to fit safety-valve bush on barrel. The ball is a press fit in the cup, the edge being spun over, and the spring is 22 gauge tinned steel wire. The cap is merely a slice of 5/16" rod, screwed as shown, and nicked to let the steam out.

The casing may be turned from a casting, or from a piece of $1\frac{1}{4}$" thick-walled tube, or even from the solid ; but I believe Kennion will be putting some stamped casings, of all shapes and sizes, on the market soon, and, if so, it will save a dickens of a lot of work. Two slots will have to be filed to clear the top feed elbows, but these are done after the latter are fitted.

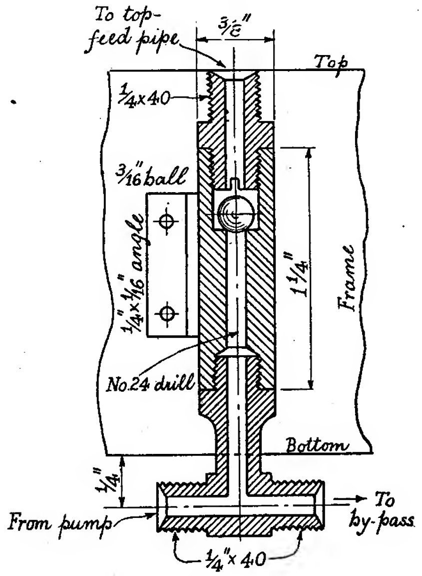
Top Feed Fittings

These are simple enough, each consisting of a tiny dolly turned from $\frac{3}{8}$" brass rod, $\frac{1}{2}$" high, rounded at top, with a 3/16" spigot about 3/16" long at the bottom. This is drilled up No. 40, and a bit of 5/32" copper pipe about 5" long, silver-soldered into the side of each. They are then screwed into tapped holes at each side of the safety-valve bushing (see sketch), a touch of soft-solder being run in around the threads to make certain of a seal. Bushes, of course, *could* be used, but they tend to make the lot appear clumsy just at the place where it would be most apparent. The pipes are bent to lie close to the boiler-barrel after the fittings are sweated in ; the union-nuts at the lower end can be left until the boiler is ready for final mounting, when the pipes can be cut off to exact length required.

Feed Clacks

Shure, Pathrick, me bhoy, we'll be afther havin' to put the top clacks at the bottom, both for appearance and convenience, and the best place to install them is on the frames directly below the pipes, where the unions can easily be got at. They are attached to the main frames, alongside the eccentric-rods, and just behind the weigh-shaft. The body is a piece of $\frac{3}{8}$" brass rod, $1\frac{1}{2}$" long, drilled and tapped $\frac{1}{4}$" by 40 at bottom, and fitted with a ball-valve and union-cap at the upper end, same as the valve-box of a pump, so we needn't detail all that out. The sketch explains itself. An inch or so of 1/16" by $\frac{1}{4}$" angle is silver-soldered to the side, for screwing the gadget to the frame. Note: the lower end of the clack for the axle-driven pump has a tee-piece at the bottom end, as shown ; one branch is connected to the pump delivery, and the other to the by-pass cock. When the latter is open, the water from the pump " short-circuits " the clack and returns to the tender ; but if the cock is shut, it has to go up through the clack, and the top feed pipe (which is connected directly to the union) into the boiler.

The clack for the hand-pump is made the same way, excepting that, instead of a tee at the bottom,



Delivery clack.

an elbow is provided. This is directly connected by a 5/32" pipe, to a $\frac{1}{4}$" by 26 union-screw on a bracket under the drag-beam, which accommodates the hand feed pipe from the tender. See coming diagram of pipe work. If the boiler is now placed temporarily in position, the top feed pipes may be bent to shape and cut to length for meeting these clack fittings, and provided with the necessary union-nuts and cones. A 5/32" pipe may also be run from the delivery union of the mechanical pump, to the leading union of the tee under the clack on the right-hand side of the engine.

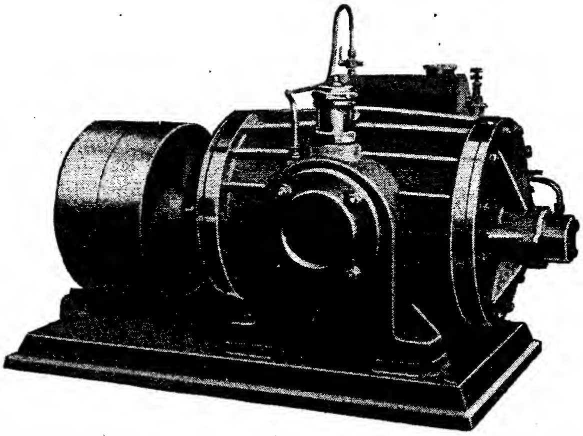
Some Interesting Exhibits at the Birmingham B.I.F.

ONE of the most attractive stands at the recent British Industries Fair, at Birmingham, was that arranged by Messrs. James Neill and Co. (Sheffield), Ltd., for the display of their well-known " Eclipse " specialities. " Eclipse " hacksaw blades were shown in a range of types and sizes to meet all requirements in the cutting of metals. The "Eclipse" hacksaw blade selector and sawing guide gives immediate information as to the correct blade and the most suitable conditions for cutting practically any given material, and these guides are available free of charge for the assistance of users.

The full range of " Eclipse " hacksaw frames was also displayed, featuring adjustable frames, fixed frames, girder frames for deep sawing; and, also, the unique 30 M. magazine frame, which carries spare blades in the handle, and is produced specially for the use of outside operators. The " Eclipse " non-electric magnetic chuck was demonstrated in the full range, which includes four sizes of the rectangular type, which meet all general machine-shop and production requirements. Added to these are two circular models for use on *lathes* and various types of grinding machines.

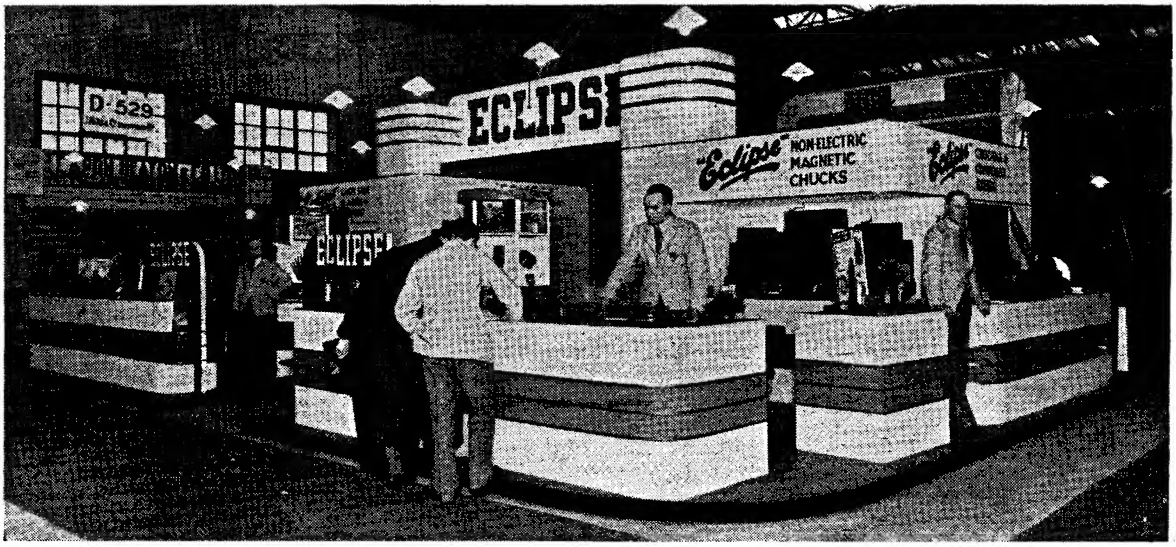
A further model on view was the "Eclipse" Minor Chuck. This model is designed for handling small parts, and can be used directly on the machine table, with a magnetic chuck, on the bench, or in the hand. It measures 5" × 2½" × 2½", having two separate magnetic faces, one with a close arrangement of poles for the accommodation of a group of small parts, or for thin material, whilst the other has a central pole arrangement to deal efficiently with heavier sections. In the switching arrangements, provision is made for energising the faces separately or together, as well as leaving both in the de-energised state, thus increasing considerably the sphere of usefulness. The "Eclipse" quick-release hand magnet—a handy tool for separating, shorting, or handling small ferrous parts—was also demonstrated on the stand.

Another stand which contained many items of interest to our readers was that of Messrs. William Allday & Co., Ltd., of Birmingham. In addition to a full range of portable forges for both coke and gas firing, there were a number of blowers of various types. Our illustration shows a large-volume blower of the sliding-vane type. It is air-cooled, and gives a positive pressure. Air-cooled blowers give pressure up to 5lb., and water-cooled machines up to 10 lb., per square inch. Lower air-pressures are provided for by the " Alcosa " motor-driven high-pressure fan,



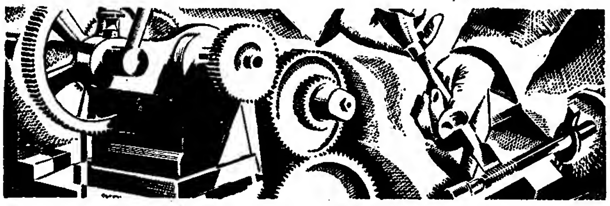
A large-volume blower of the sliding-vane type, on Messrs. William Allday & Co.'s stand at the Birmingham B.I.F.

giving a large volume of air at a pressure of 2 lb. per square inch. Messrs. A. H. Wilkes & Co., a subsidiary company of Messrs. Allday, showed a number of their " Wilkes " soldering furnaces, and equipment for both hard- and soft-soldering. This equipment is now made suitable for use with " Calor " gas.



Messrs. James Neill and Co. (Sheffield) Ltd. stand at the British Industries Fair, Birmingham.

TOOL-ROOM TOPICS



Gauging Dovetail Slides

By R. HUTCHESON

A CORRESPONDENT has been called upon to make some gauges for checking small dovetail slides, and he is desirous of knowing the best type of gauge for the job.

There are two commonly used methods of gauging dovetails: one entails the employment of a profile gauge, while the other calls for the use of two cylinders which are nested in the angles, and the size of the dovetail is judged from the distance apart of the cylinders ; the principles underlying the two systems of gauging will be discussed.

A male dovetail is indicated at Fig. 1, and there are two important dimensions to be checked, viz., the angle α of each side, and the distance the two sloping sides are apart. The first dimension is definite, but what is the distance between the two slanting sides?

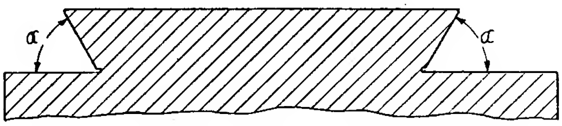


Fig. 1. A section through a male dovetail slide.

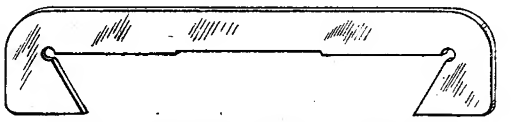


Fig. 2. A profile gauge for a male slide.

When large numbers of slides of the same width and angle of dovetail are to be produced, some form of profile gauge can be made, the simplest gauge of this type being that shown in Fig. 2. This gauge is made of gauge steel, *i.e.*, a bright flat strip steel capable of being hardened, the thickness depending upon the length, and being sufficient to ensure that the gauge is rigid.

If one examines a pair of machine parts which are dovetailed together, to slide one upon the other, it will be noticed that no attempt is made to get the slides to fit at both the top and the bottom, but a decided clearance is left between one or other pair of faces, as is indicated in Fig. 3 ; the arrangement shown at *A*, where the upper faces are in contact, being used almost invariably, rather than that at *B*, where the under faces are in contact. A clearance is also left in the extreme corners.

The clearance between the faces must be allowed for on profile gauges, so that the gauges, when applied to the work, will bear only on the slopes of the dovetails and the other rubbing faces, the gauges not making contact with the faces between which there will normally be a clearance.

Gauging with profile gauges in this manner can be elaborated upon when the slides are to be machined to limits, and limit gauges of this type will be described shortly.

Gauging dovetails with the aid of cylinders is common. A female slide is shown in Fig. 4, and a small cylinder or disc, *a*, is nested in each corner. The distance apart of the inclined sides is obtained by measuring the distance *l* between the two cylinders. The male slide is tested in a similar manner by arranging the cylinders on the slide, in the manner shown in Fig. 5, and determining the distance *L* over them.

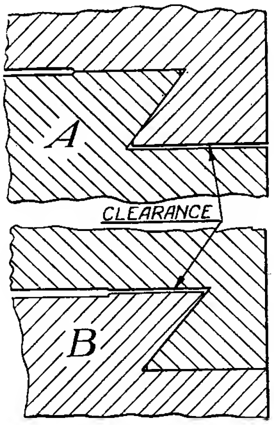


Fig. 3. No attempt is made to obtain a sliding fit between both the upper and lower parallel faces, but a clearance is left between one pair.

This test alone is not sufficient, as can be judged from Fig. 6. Two slides are shown, one having dovetails of about 75 degrees, and the other having dovetails of about 30 degrees. The cylinders that are nested into the corners are all of the same diameter, and the cylinders in each pair are exactly the same distance apart ; it is evident that even though the distances *l* and *L* of Figs. 4 and 5 be correct, the angles of the dovetails can be far from accurate.

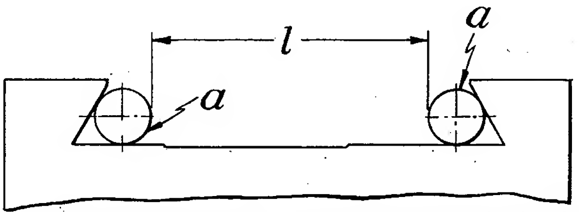


Fig. 4. The distance apart of the sloping sides of a female slide can be determined by gauging between a pair of cylinders *a*, *a*.

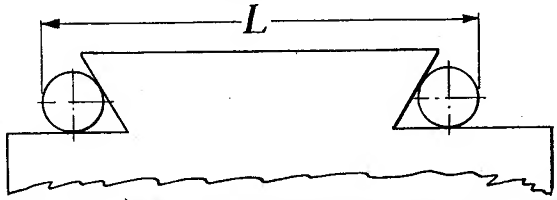


Fig. 5. "Cylinder" gauging applied to a male dovetail slide.

Checking the distance between centres of a pair of rollers in the above manner must be accompanied by an independent checking of the angles.

The angles themselves can be checked by means of profile gauges, and the gauges are best made so that they measure the angle between the flat rubbing face of the slide and the inclined side. Taking the two slides shown at *A* in Fig. 3, they can be tested by gauges in the manner depicted by Fig. 7. When

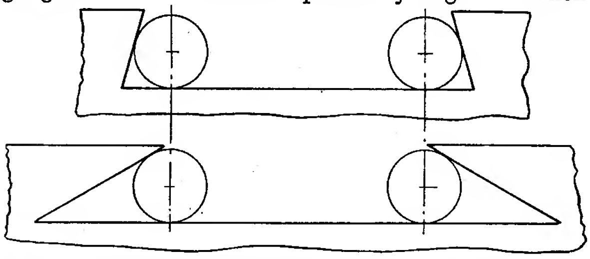


Fig. 6. Gauging the centre to centre distance of the cylinders is not a sufficient check on the angles.

slides are being machined the first cuts taken should be directed towards obtaining a correct inclination, which can be tested by the gauges of Fig. 7, after which the precise distance apart of the inclined faces can be gauged with the aid of the cylinders.

When a dovetail is to be machined, the angle α and depth h are given, and also the full *angular* width of the slide either at the large or small end of the dovetail, as is indicated by the dimensions

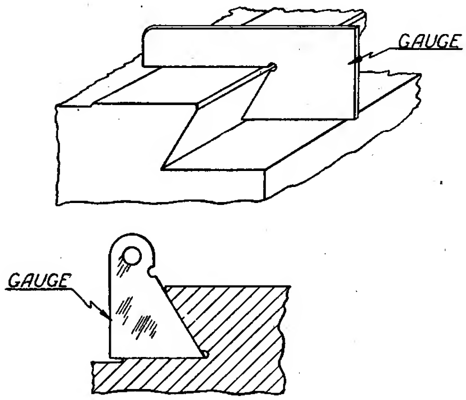


Fig. 7. Profile gauges for testing the slope of the sides.

W and w, respectively, in Fig. 8. By "angular" width is meant the width if the angles were continued to sharp corners in the manner of Fig. 8.

Considering, firstly, the male slide, the distance L over the cylinders is given by the formula:—

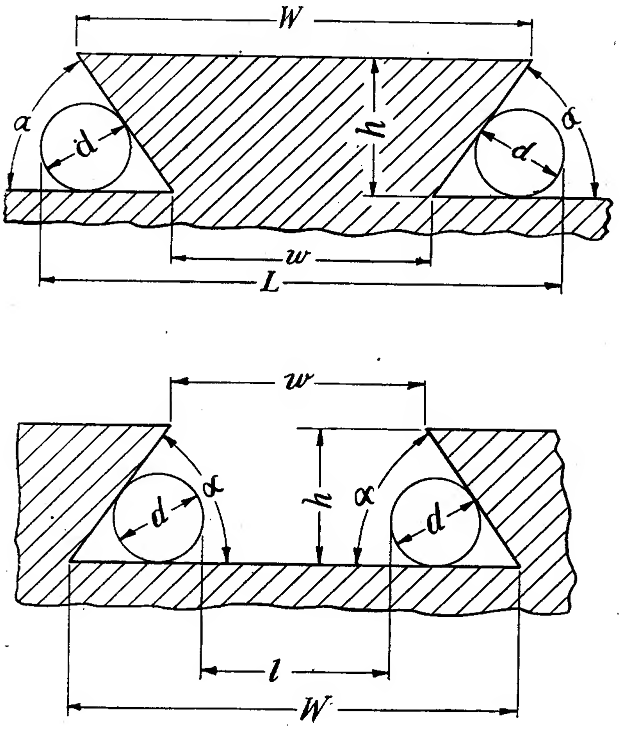
$$L=d\left(1+\text{Cot}\frac{\alpha}{2}\right)+w$$

If the greater width W were given, instead of the smaller width w, then the smaller width could be readily determined by trigonometry.

For a female slide (Fig. 9) the distance l between the cylinders can be determined from the formula:

$$l=W-d\left(1+\text{Cot}\frac{\alpha}{2}\right)$$

The distance L over the rollers of a male slide can be readily measured by means of a micrometer, or a vernier caliper. If the work is being machined to limits, a stepped gap gauge, made of plate, can be employed to check the overall dimension.



Figs. 8 and 9. The dimensions to be considered in gauging dovetail slides.

In the case of the female slide, the distance l can be checked by means of the internal jaws of a vernier caliper, or by means of an internal micrometer.

The Largest Diesel-Electric Locomotive in the World

Capable of hauling a loaded 14-car train at a speed of 117 miles per hour, and scheduled to make the trip from Chicago to Los Angeles in 39¾ hours, the Union Pacific's newest streamlined locomotive, "*City of Los Angeles,*" with motors, generators, and auxiliary equipment furnished by the General Electric Company of New York, will soon be in regular passenger service.

The three-unit 5,400 h.p. diesel-electric locomotive that furnishes the motive power for the train is the largest locomotive of this type yet built. It is powered by six 900 h.p. engines, and has six electric generators, which furnish the power to drive the twelve high-speed traction motors on the six three-axle trucks. The traction motors are similar to those in successful use on other high-speed diesel-electric trains.

Directly behind the third unit of the locomotive is the auxiliary power car which contains two diesel engines, each of which drives a General Electric 300-kW alternating-current generator. The two alternators are connected in parallel to supply 600-kW of 60-cycle current to the train line. This current will be used to heat, light, and air condition the train.

Some Elementary Aspects of Superheating

With Reference to Model Locomotives

By H. GREENWOOD

IN this brief article, it is not proposed to enter into any technicalities, but, rather, to treat the subject in the nature of an informal discussion, using the basic features of real full-size steam engineering practice to point the way along which success is most likely to be achieved. The purpose of a superheater is not only the prevention of loss through condensation in the steam-pipes, but the addition of a sufficient amount of superheat to the steam before it enters the cylinder, as will make up for that robbed by the cylinder-walls, so that the steam will remain practically dry—at all events, up to the point of cut-off.

The principles upon which a superheater should be constructed, to give a sufficiently high temperature, are:—

(i) The superheater should be placed in a position where a suitable temperature is available. If a boiler is working under economical conditions, the difference between the temperature of the saturated steam, and of the flue gases leaving the boiler, is not sufficient to superheat the steam produced, unless the surface of the superheater is very large; therefore, smokebox superheaters may be ruled out of court. On the other hand, if placed too near to the boiler firebox, there is a greater liability to damage from the impact of the flame.

(ii) The superheater should be constructed to allow the elements free expansion, and contraction, without putting severe strains on any joints which might cause them to leak.

(iii) The areas through which the steam passes should be in excess of the steam inlet and outlet connections to avoid drop in pressure.

(iv) The steam should be circulated rapidly.

So much for the general considerations. In full-size practice, a final steam temperature of 500° F. would be about the maximum desirable, as a general rule, for reciprocating steam engines.

In Fig. 1 is shown a typical superheater element for a loco.-type boiler in its flue-tube. The heating element is of the conventional spearhead type, and terminates a sufficient distance from the firebox to avoid damage due to overheating. Superheater elements of this type may quite well be constructed of solid drawn copper tube, with brazed joints. A superheater, constructed in this manner, is of the convection type. The element is out of the direct radiant-heat rays from the incandescent fire, and relies on the hot flue gases to impart sufficient heat to dry the steam.

Referring to Fig. 1 again, the greatest heat exchange, from the flue gases to the steam, will take place in the top limb of the element, where we have contraflow conditions. The wet steam, entering at the smokebox end, will be surrounded by flue gases at their lowest temperature, prior to being expelled out of the chimney; as the steam flows towards the firebox end of the element, it will be surrounded by gases of increasing temperature, and the maximum temperature of the steam will, probably, be reached, approximately, at the point B, after which it will not gather any appreciable rise in temperature, as both steam and flue gases will be travelling in the same direction; but the surrounding flue gases are now decreasing in temperature, as they travel towards the smokebox. The greatest danger, now, will be to avoid any heat being returned from the steam to the flue gases, by keeping the velocity of the steam-flow at a sufficiently high rate.

Before passing on to the radiant-heat, or firebox type, of superheater, it may be as well to state briefly the characteristics of the convection type of superheater, as shown in Fig. 1. The steam temperature, from a superheater of this type, will fluctuate, to a large degree, by the load on the boiler, as it is easy to see that the harder the boiler is fired, the greater will be the volume of flue gases passing through the flues, and the velocity of these gases will increase as the speed of the loco. increases, due to the steady, intensified draught set up by the blast from the exhaust-pipe. On a long, sustained, non-stop run, the steam temperature will remain at a steady figure; but, should the speed, and the load on the boiler, fall off, there will be a corresponding falling-off in steam temperature from the superheater.

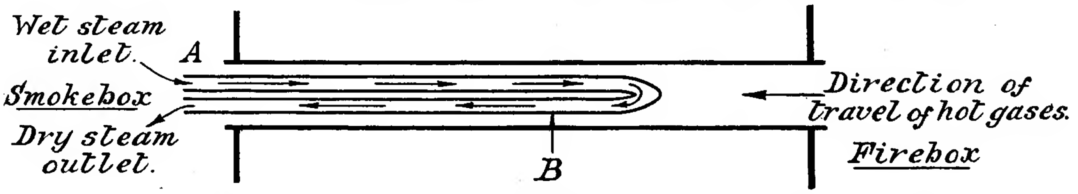


Fig. 1. Single element of convection type superheater in model loco. flue tube.

Fig. 2 shows, diagrammatically, the element of a radiant-heat, or firebox type, of superheater. Here we have a considerable portion of the superheater heating surface in direct contact with the flame, and heat-rays, from the incandescent fire. The heat imparted to the steam in the element, from the flue gases, will be negligible, in comparison with the heat given to the steam while traversing the firebox section of the superheater.

The steam supplied, from a superheater of this type, will not vary in temperature to anything like the same extent as the convection, or flue-tube, type; it will be more independent of the load on the boiler, as it is always in contact with the radiant-heat from the fire, and does not depend so much on the draught created by the blast-pipe to draw the heating medium in contact with the elements.

Nothing will be gained by keeping the velocity of the steam through the elements at a very low figure, because, whatever type of superheater is fitted, for two similar boilers to be economical, and equally efficient, they must have the same smokebox, or exit flue gas temperature, and if, after raising the steam to a very high temperature in the firebox, it is allowed to travel at a very slow rate to the smokebox, on its way to the cylinders, heat will be given up to the flue gases, while the steam and flue gases are travelling in the same direction towards the smokebox.

The characteristics of the flue-tube and firebox type of superheater may be tabulated, as follows:—

Flue-tube, or Convection Type, Superheater

The steam temperature varies, to a greater extent, with the load, than it does with the firebox type. High superheat will be obtained at times of hard steaming, and very low steam temperatures at low loads. The elements are not subject to such severe working stresses as the firebox type, and, therefore, do not call for special materials, or constructional features, and will have a higher factor of safety in operation.

Firebox, or Radiant-heat Type, Superheater

The steam temperature does not differ so greatly, between full load and light load, as the flue-tube type. If the boiler-fire is forced very hard, it is easily possible to get an excessive steam temperature that would be injurious to the cylinders, and cause damage to the elements. Due to the more rigorous working conditions, the materials of construction need to be carefully selected, and all joints suitably made.

From the above, we are able to deduce that, for all-round work, in conjunction with a boiler that is capable of burning any sort of coal, on a loco. used for continuous work, a flue-tube superheater will be the most satisfactory. If the loco. is capable of burning any sort of coal, it will have a good blast, because, with inferior coal, a quicker rate of combustion will be required to evaporate the same quantity of water, and, therefore, there will not be any shortage of hot flue gases surrounding the elements of the superheater. In other words, the loco. will have sufficient draught to pull the necessary air through the grate to consume the greater quantity of inferior coal.

On the other hand, a loco. with a poor blast will not be able to run on poor coal; if used on short-distance work, in conjunction with first-class coal, a firebox superheater will be very suitable, as the combustion rates will only be low, and the fire will be under easy steaming conditions, and will, most probably, never attain the fierceness requisite to cause damage to the superheater elements.

Another way of looking at it would be to say that a flue-tube superheater would be most suitable for a boiler steaming with bright fires, and a firebox superheater would be satisfactory, on a boiler steaming with lazy fires.

In both types of superheater, a number of small-bore elements is preferable to one large-bore element, whenever the limitations of space will allow for this, because a small-diameter tube may have much thinner walls than a large-diameter tube for the same factor of safety. This will give more efficient heat transfer to the steam to be superheated, as there will be less heat absorbed by the superheater metal.

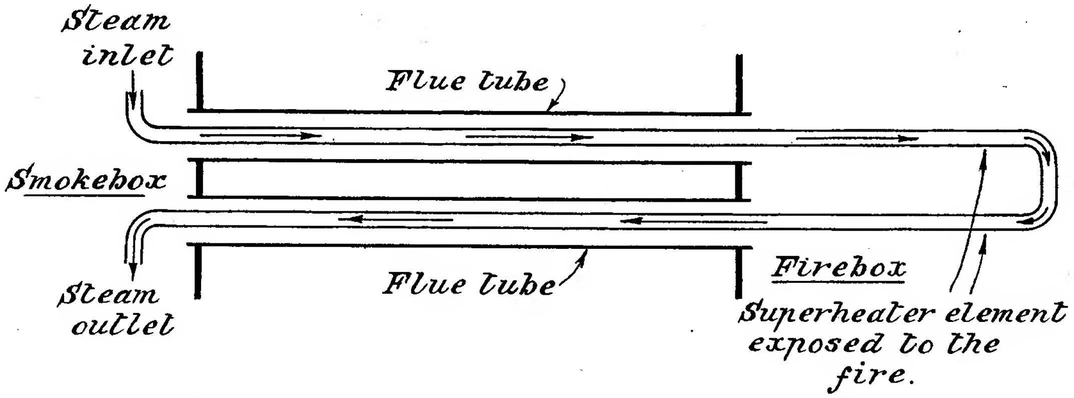


Fig. 2. Single element of radiant-heat type superheater arranged in model loco. flue tubes.

In modern land installations, a combination of radiant-heat and convection type superheater has been tried, with a view to obtaining a constant final steam temperature at all loads on the boiler, without the risk of a dangerous temperature being reached during times of high combustion rates, as is very liable to occur where the whole of the superheater heating surface is of the radiant-heat type. Also, radiant-heat type superheaters, designed for very high final steam temperatures, have been installed in conjunction with an apparatus known as a de-superheater, by means of which any excess in steam temperature likely to cause damage to the prime mover is automatically taken care of, and, as far as possible, a constant steady steam temperature at all loads, and for all rates of combustion, is maintained.

The above will show that the field for experiment in model loco. superheating is still very large. We now have eminent model loco. builders who are installing, and experimenting with, both of the types of superheater here dealt with. It is with the object in mind of explaining, in a simple way, the basic features of each type, in a form that will be readily understood by the tyro, that this short article has been written. If this has been achieved, the writer will be well satisfied.

Petrol Engine Topics

"Your Troubles—and Mine"

By EDGAR T. WESTBURY

TALES of woe are all too frequent in this troubled life, and it is not in the least surprising that, when readers write to me on the subject of model petrol engines, a very large percentage of their letters relate to their troubles—troubles with design or construction, starting or running, troubles trivial or fundamental, troubles with castings, sparking-plugs, coils, or carburettors—all elusive and brain-racking to the point of desperation.

I have done my best, on several occasions, to deal with these troubles in a general way, but I know only too well that everybody's troubles—like everybody's sweetheart—are just that little bit *"different"*; general solutions never fit individual cases. How many wireless experimenters, having built a set which should bring in Schenectady full strength, but, in reality, fails to bring in the local station at a whisper, have searched long and vainly for a solution in the "Radio Fault-finding Guide"? And the fact that it is never there cannot be held to the blame of the book.

No, all these little troubles call for individual treatment, and, so far as I am able, I am always willing to do my best to assist any experimenter. Remote diagnosis is, however, an extremely difficult matter, and one fact which is often forgotten is that a true and certain solution of any problem can only be guaranteed when *all* the data concerning it is available—a very rare condition, in my experience. It is entirely a fallacy to suppose that anyone can be led by the hand through all his troubles—this applies in model engineering, just as in the affairs of life, and, at risk of appearing discourteous, I am sometimes obliged to advise readers to apply the principles of self-help. There is an uncanny, but very useful, faculty, which, although partly inborn rather than acquired, is much more common than is supposed—that is, the ability to analyse and solve problems, irrespective of their nature. Nearly all model engineers possess this in marked degree, if they will only use it; some exercise it in solving cross-word puzzles, or forecasting football events, but others apply it to practical matters, experiment, or research, with very far-reaching results. It is something more than mere ingenuity or inventiveness, which are necessary at the outset of an experiment, but often inadequate to complete it.

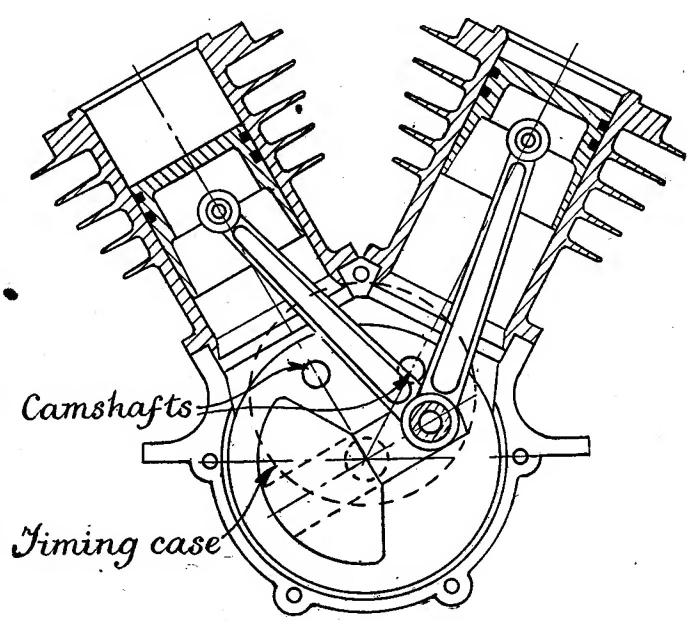


Fig. 1. A correspondent's proposed design for a 30 cc. vee twin engine, employing standard 15 cc. engine components.

An Apology

This is by no means to be regarded as a dismissal of readers' problems, but may, perhaps, be allowed to serve as a pretext for inflicting on them one of my own. For some time now, I have been very concerned about the growing volume of my correspondence, which has made it extremely difficult to deal properly with each individual letter, and, at the present date, I am several months in arrears with replies to quite a number of letters of outstanding interest, with very little hope of being able to make up schedule time.

There is not one of these letters which I can dismiss with a brief reply; some of them run to four or six closely-packed pages, with drawings, and, occasionally, photographs. Yet, if I keep them waiting for a reply much longer, I shall probably find that my correspondents have given up petrol engines and turned to some less exacting pursuit, such as stamp collecting. Up to now, they have shown remarkable forbearance, but some of them must have formed a rather poor opinion of my helpfulness and courtesy. What is to be done about it?

There are several possible solutions of this difficulty; the simplest, of course, would be to send each queriest a stereotyped note, regretting my ability to deal with his problem, owing to the demands on my spare time. This is by no means a welcome solution to me, because I am conscientiously interested in all these problems, and a reply of this nature constitutes a rebuff which discourages the querist, and gives the impression that his troubles are beneath my consideration. Another suggested solution would be to charge a fee for special advice, the amount to be based on the time involved, to the encroachment upon leisure or more profitably-occupied time. This, I am even more reluctant to do; while I should feel no compunction in extracting a fee from a querist of ample means, such are extremely rare in the ranks of model engineering. Quite a large proportion of my letters are, obviously, from readers who are not at all well-blessed with this world's goods, and often have to resort to devious expedients to save money, in order to carry on with their hobby.

I have discussed this difficulty with the Editor, who agrees with me that, while it is almost impossible for me to cope adequately with all queries received, a partial solution might be found by devoting an occasional article, under "Petrol Engine Topics," to matters arising out of them, which appear to

be of general interest. I shall be glad to know whether this course is acceptable to readers. Do not think that I wish this voluminous correspondence to stop ; every one of these long, friendly letters is read with the greatest interest, and gives me an adequate proof of the growing popularity of model petrol engines. Incidentally, I may mention that all the foregoing remarks apply equally to letters on the subject of flash steam.

Problems in Design

I have always the greatest enthusiasm for the novice who essays to design his own engine ; nearly all the designs which are submitted for my approval embody some refreshingly original ideas, and these are absolutely essential to progress in design. Unfortunately, however, many novices rush lightheartedly into an ambitious design without realising what they are up against. Just as the novice locomotive constructor scorns to build a simple four-coupled shunter as his first attempt, and wants to start on a "Pacific," or even a "Mallet" Compound, so does the beginner with model petrol engines cherish dreams of an eighteen-cylinder supercharged engine, or a 1 c.c. Diesel. A proposed design may be good, even to brilliance, in parts, but that alone is not sufficient ; it must be perfectly sound in every part, what is less commonly realised, when one has evolved the "100 per cent. perfect" design, there is still the job of building it! Generally speaking, an engine of mediocre design, really well built, is a much greater success than one of brilliant design which is just let down by minor faults in workmanship. The ideal combination of excellent design and execution is, I assure you, quite rare.

I think that, in a general way, the novice is much better advised to build an engine of a more or less proved type, than to attempt his own engine design, until considerable experience has been gained. It is quite likely that the latter will reveal quite a few fallacies in one's original reasoning, and the result may be that the "ideal design" of one's early dreams never materialises, in the light of more mature knowledge.

But, while no good purpose is served by encouraging a novice to proceed with a design which one knows to contain fatal snags, the summary condemnation of it may do equal harm by discouraging real ingenuity, and I try, therefore, to give an analysis of any design submitted, pointing out what features are good or bad, and why. Readers are advised never to submit anything which may be secret, or intended to form the subject of a patent, for, though confidence is always respected, there is always a possibility that the idea may crop up in another place, and this may lead to misunderstanding. Many experimenters do not realise that others may be working along almost identical lines, and that ideas often overlap.

Some Notes on Twin-cylinder Petrol Engines

Among the many designs which have been submitted for my opinion, I note that a very large proportion show a tendency to break away from the monotony of the single-cylinder engine. I have every sympathy with this move, but there are many practical difficulties, and, even, definite limitations, in developing engines of more than one cylinder, that make experienced designers generally cling to the good old "one-lunger" with the tenacity of a drowning man to the proverbial straw.

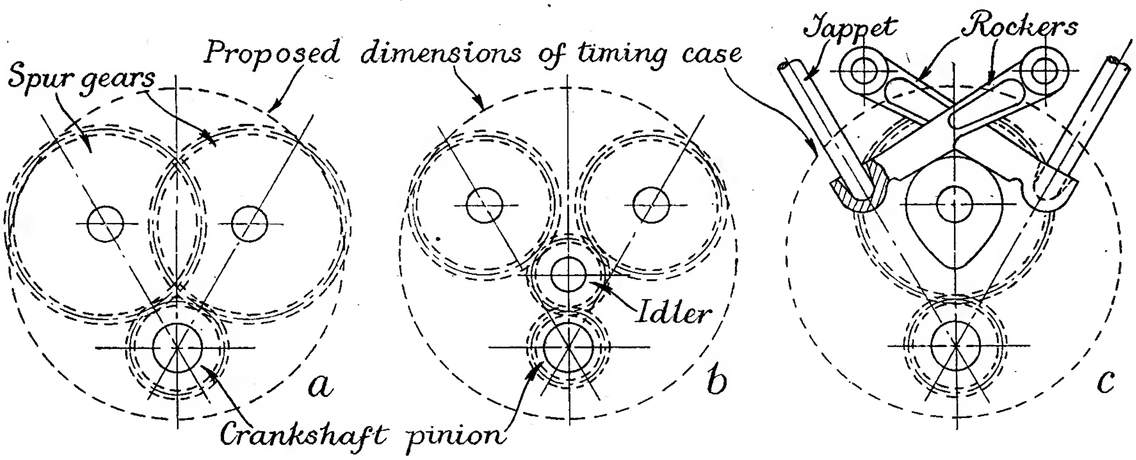


Fig. 2. Diagrams illustrating problems in timing gear for vee twin engines : *a*, showing overlapping of standard size spur gears ; *b*, the use of smaller gears and pinions, with an idler pinion interposed to correct spacing ; *c*, a single camshaft with four cams operating tappets through swinging rockers. Note that in all cases the complete gear exceeds the dimensions of the proposed timing case as shown by dotted lines in Fig. 1.

A Ruislip correspondent has submitted a proposed design for a vee twin 30 c.c. engine, which may serve as a typical example of the type of problem likely to be encountered. His idea is to build a vee twin engine, with the two 15 c.c. cylinders disposed at either 60 or 90 degrees to each other, and, to avoid a good deal of special pattern-making, he proposes using "standard" 15 c.c. engine parts, so far as possible ; actually, the crankcase would be the only special casting required.

One form of the proposed design is shown in Fig. 1, which represents the cylinder and crankcase arrangement of a 60 degrees vee twin, having cylinders, pistons, and practically all other components which are not shown in the drawing, of the type employed in the 15 c.c. engine which I described two years ago.

There are several rather attractive possibilities in such a scheme, but there are, also, one or two snags, not necessarily unsurmountable, but calling for a good deal of careful consideration ; I suspect that my correspondent has already scented them, and is "trying it out on the dog" before proceeding further.

First, as to the advantages: the first is, that it would produce a 30 c.c. engine of much more compact space dimensions and lower centre of

gravity than is possible with a single cylinder. The torque would be more even—that is to say, the ratio of maximum to mean torque would be lower, so that a given power could be transmitted with less mechanical strain and wear on the working parts. By using components which are known to work quite well on a single-cylinder engine, a good deal of uncertainty regarding the success of such details can be eliminated, and such items as valves, springs, etc., will work under much easier conditions than heavier ones, as required on a single-cylinder 30 c.c. engine.

Now, the disadvantages: first and foremost is the fact that mechanical efficiency is almost bound to be lower in any engine in which the frictional surface is vastly increased—an inevitable result of increasing the number of working parts. Many designers do not realise how far-reaching an effect mechanical friction has on actual power production in small engines. I am open to contradiction on this point, but I believe that in engines of moderate size—say, up to half a litre in capacity—multi-cylinders are always far below single-cylinders, size-for-size, in power output, for the above reason. In much larger engines, of course, the use of a single cylinder becomes impossible, for reasons connected with cooling, balancing, etc.

The choice of cylinder-arrangement adopted by my correspondent is hardly a happy one, in my opinion, as the vee twin is a particularly difficult type of engine to design nicely, and has some peculiar running characteristics which are inherent and not always desirable. Originally, I suppose its excuse for existence was that it fitted quite nicely inside the conventional motor-cycle frame, and a considerable amount of development work has been done on it for this purpose, but its popularity has been on the decline for several years now. I have seen several model vee-twins, but not one that really struck me as being a nicely-running engine. The uneven cyclic spacing of the cylinders gives an engine of this type a peculiar hunting vibration, which is often more difficult to deal with, in practice, than the heavier harmonic thump of a single. For the same reason, mixture distribution and carburation tend to be rather difficult, and I have wrestled for many hours with those one-time favourites of the "he-man" motor-cyclist, the "big vees," in the attempt to get both cylinders to fire at all speeds. The inference, from experience with models, is that these troubles would be accentuated in a small engine.

Other minor disadvantages, which apply to any engine of more than one cylinder, are the complication of ignition-gear and the necessity for fitting a distributor; also, a branched induction-pipe.

A Mechanical Snag

Vee-twin engines often introduce some special problems in the design of the timing-gear, and this example is no exception. It is proposed to fit two camshafts, situated immediately below and on the centre-line of the cylinders, as indicated in the sketch submitted. This, however, is not so straightforward as it looks, as the space allowed for the gears is somewhat restricted, and, by going a little more deeply into this matter, it will be seen that normal timing-gears could not be accommodated (Fig. 2*a*), unless they are staggered, necessitating the use of a pinion of double-face width. A possible means of overcoming this difficulty would be to use smaller gears than normal, and introduce an idler gear (Fig. 2*b*). Yet another solution consists of fitting a single camshaft, and by using pivoted-cam followers, to transmit motion to tappets situated on the centre-lines of the cylinders, from two pairs of cams, as in Fig. 2*c*. (Note that these multiply the lift, and this must be allowed for in the cam design.) A great deal of ingenuity has been applied to the timing-gear of vee-twin engines, and, in such cases, a single cam has been employed to operate both exhaust and inlet valves.

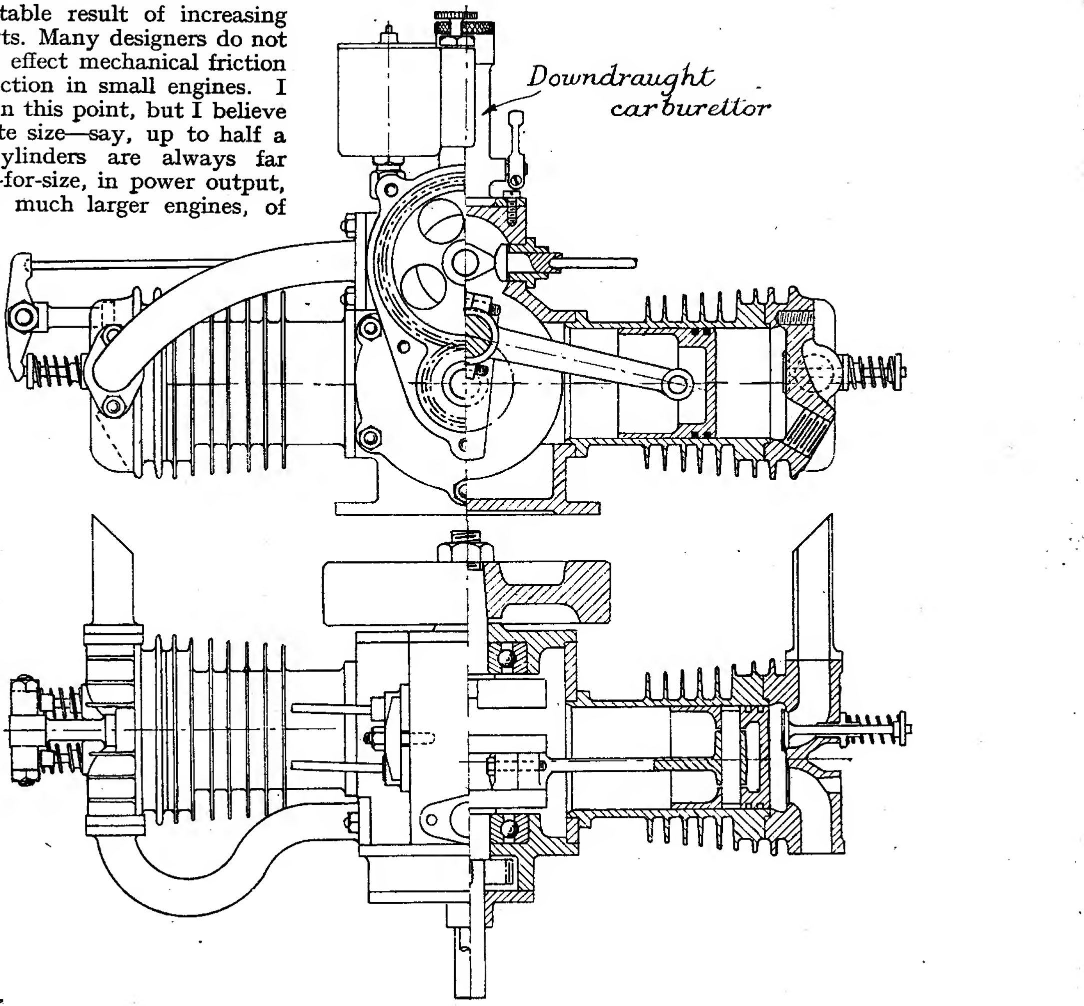
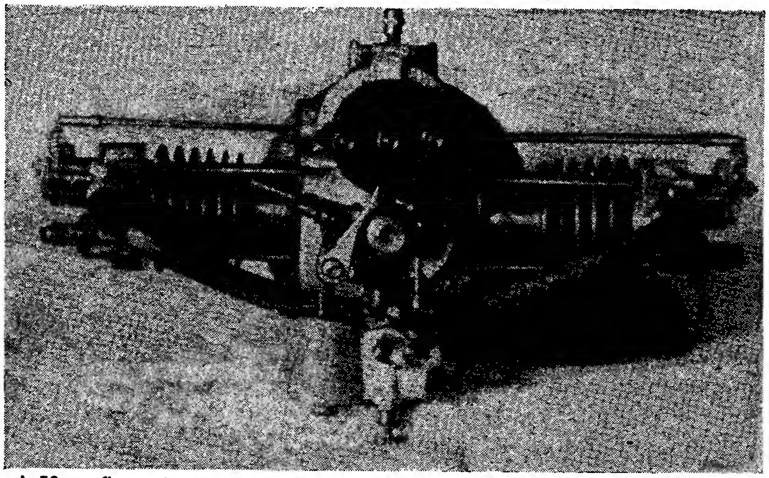


Fig. 3. A suggestion for a 30 cc. horizontally-opposed twin engine using standard 15 cc. engine parts, and embodying several unorthodox features of design.

An Alternative Suggestion for a Twin Engine

As this subject is very much in the air (from some of my correspondents' suggestions, one is almost tempted to say "in the hair!"), it may be permissible for me to illustrate a proposed design, which I drew out some time ago, and, also, incorporates the idea of employing "standard" 15 c.c. engine parts, with suitable modifications. The discussion of an untried design is contrary to my usual practice, as I very much prefer to wait until my design has been built and tested before making a "song" about it; but one or two of my correspondents seem to imply that I have rather neglected the matter of progressive design, in engines that break away from conventional practice, so here goes!



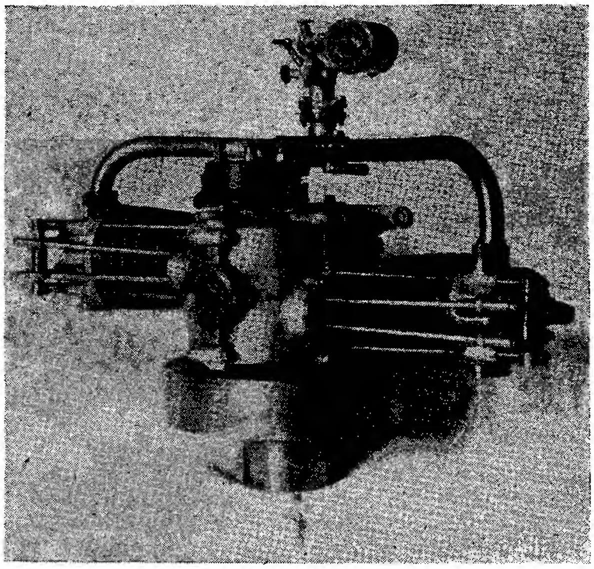
A 50 cc. flat twin engine constructed some years ago by Mr. Elmer Wall, of Chicago. Note that contact-breaker is on crankshaft, and h.t. distributor on camshaft.

This design, shown in Fig. 3, is an example of the horizontally-opposed twin, a type of engine which figures largely in the enthusiast's dreams, but is generally rather better in theory than it is in practice. The fact that it provides something approaching perfect dynamic balance is not, after all, such an enormous advantage in a small engine, and decreases almost to imperceptibility as the size is reduced. A far more important advantage, in practice—especially for boat work—is its very low centre of gravity, and the facility which it offers for "top streamlining," and the concealment and protection of plant. An engine of normal bore/stroke ratio, however, tends to be rather excessively wide, for a boat of normal beam, and, in this design, I have found it desirable to shorten the stroke to 1" and increase the bore to 1 1/16", thus rather spoiling the idea of standardising the cylinders, pistons, etc., with those of my 15 c.c. engine; but the cylinder-heads, and a good many other items, will work in.

A feature of the flat twin engine, which often gives trouble in practice, is the necessity for a long induction-pipe, which tends to cause the re-condensation of mixture and faulty distribution to the two cylinders. This is sometimes avoided by using a separate carburettor for each cylinder, which is a fairly successful measure on large engines, but, in a model, it is extremely doubtful whether the remedy would be much better than the disease, owing to the extreme difficulty of synchronising two tiny carburettors.

In the proposed design, I have made some attempt to improve distribution from a single carburettor by forming the centre portion of the induction-pipe in the crankcase casting. This region is always fairly warm, when the engine is running at full power, and thus, the condensation will be much less than with an entirely separate pipe; also, the carburettor attachment is more rigid and secure. Incidentally, many users of flat twin engines, in the old days, attempted to reduce condensation trouble by lagging the induction-pipe with asbestos string. This idea was entirely a fallacy, as the temperature in the pipe was below that of the atmosphere, and the lagging, instead of "keeping the pipe warm," as they supposed, had the effect of actually lowering the internal temperature by keeping the pipe isolated from external effects.

The carburettor proposed for this engine is of the down-draught type, which is far easier to accommodate, in this case, than one of more normal type, but special provision is necessary to avoid the possibility of the induction-pipe becoming flooded. A point about the induction system, which is not explained by the drawings, is the communication between the carburettor-flange, at the top of the crankcase, and the branch induction-pipes leading to the two cylinders. This is effected by making the camshaft bearing-housing in the form of a bobbin, with deep cheeks, so that there is an annular space around it, forming a communication-way between the three ports. Incidentally, the use of a junction of this type, instead of the more common T- or Y-joint, is a very old dodge for the improvement of distribution, and the prevention of blow-back, in induction systems with long branches, similar to this. One very interesting point about this engine is that, with very slight modifications to the normal design,



View from above Wall flat twin engine. The horizontal automatic carburettor works on a similar principle to that of the original "Atom" carburettor, described some years ago in the "M.E."

it can be supercharged by the crankcase compression method, and thus, offers many possibilities for experimental work. The design, or such parts of it as are illustrated, is not claimed to be complete, but all details have been worked out, and I have very little doubt that, in a general sense, it would be quite successful in practice. Whether the amount of interest in engines of more than one cylinder would justify treating it in greater detail, is open to question.

Other Unconventional Engines

It is, of course, one thing to put elaborate engine designs on paper, and quite another to build them; this, probably, explains that, in spite of the fervent protests against the crudity of conventional designs, most of the engines one sees constructed still embody the same old time-honoured features. For the same reasons, I have always tried to encourage soundness in mechanical principles, rather than elaboration, but I still have a very keen interest in engines that break away from convention; and, if left to my own devices, should probably produce weird contraptions which would hardly be recognised as engines, and, quite possibly, would introduce so many new problems that their practical success would be very poor. That is always the danger with anything really new in design, and one can only be reasonably sure of the success of any design after a good deal of practical experience with a number of very similar engines. Readers who have asked my advice regarding designs incorporating rotary- or sleeve-valves, opposed pistons, or other very unusual features, should bear this in mind. The designs I offer to readers are not necessarily my ultimate ideals, and I have, even now, embarked on an engine which is a long way off the beaten track, in its design, but details will not be made public until its success has been proved—which may be a long time, if at all.

First Steps in Model Engineering

Workshop Advice, Experience and Philosophy for Readers of all Ages

By " INCHOMETER "

Magnets and their Polarity

A magnet has two poles, conventionally termed North and South respectively, indicated by the letters *N* and *S*; the *N* pole is the one which points to North, in the magnetic compass. For convenience, it is generally assumed that magnetism—magnetic lines of force—flow out of the *N* pole of the magnet, and enter it at the *S* pole. In a dynamo, the magnetism comes out of the *N* pole of the field magnet, through the core of the armature, and enters the magnet at the *S* pole. The core of the armature is made of iron—or, nowadays, a soft kind of steel which is a good conductor of magnetism. Neglecting secondary effects and influences, the armature core may be regarded as merely providing an easy path for the field magnetism to flow from the *N* pole to the *S* pole of the magnet, and not to be a producer of magnetism. The objective is to establish a concentrated field of magnetism, in which the armature coils, or loops, shall be moved about. Visualise three principal elements—the field magnet, producing the magnetism; the armature core, conducting the magnetism from *N* to *S*; and the wire upon the armature core, producing voltage and current. For convenience of general construction, the armature core is rotated along with the wire, or winding. In early times, the core was made solid; now it is always, in general use, built up of thin discs, to prevent wasteful local currents being produced in its bulk; these are termed Foucault, or eddy currents. If you decide to made a dynamo, the armature core may be solid, but the amount of driving power required will be greater, and heat will be generated in the core, by reason of these eddy currents.

Types of Field Magnets

The particular form of the field magnet does not affect the main, and essential, principles of working. In small dynamos, as generally used for home workshop purposes, the field magnet is of the two-pole, or bi-polar type, as this is termed. The multi-polar type, having more than two poles, is more adapted for machines of larger output. Possibly, you may have a four-pole field magnet dynamo; in effect, its working is the same as with a two-pole field magnet. A magnet does not have four magnetic poles. Either, or both, poles may be divided, spread out into fingers, as may be expressed, but these will all have like polarity at each pole. A four-pole field magnet is, actually, four magnets placed, or combined, together, with all like poles in juxtaposition. There are dynamos (and motors) having small field poles in between the main poles; these extra poles are auxiliaries, are termed commutating poles. They are for the purpose of assisting commutation—that means, preventing sparking at the brushes, and not for contributing to the magnetic field. The shape of field magnet now general is circular, having inwardly projecting poles. There are still many dynamos in use which have the " horseshoe " type of field magnet, armature overhead, underneath, or at one side; also, machines of similar type to that shown by the photograph in my article of last week. With all or any one of these, you need not be perturbed about its type; all are the same, as regards general principles, and, with small sizes, practically, one is as good as another for working purposes. The old-style open-type machines have advantage in that all parts are easily seen, and are more accessible than with the shut-in modern circular form.

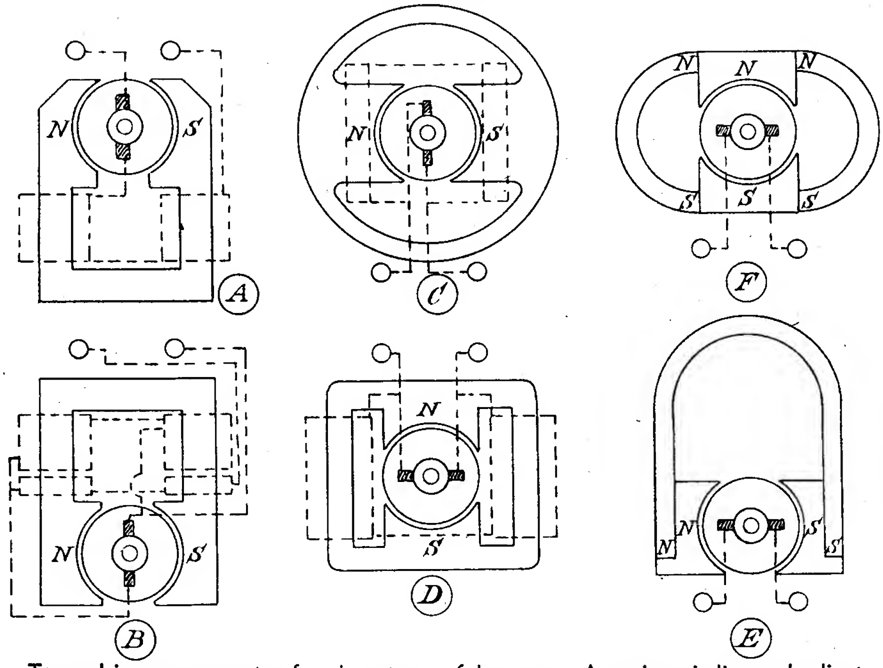
Permanent Magnet Dynamos

The magnetism is produced by a hardened steel magnet, which may have soft iron pole-pieces, in which the armature rotates. The amount of magnetism can be regarded as being permanent and constant. Actually, it tends to weaken, with course of time. Owing to this always existing field of magnetism, the machine will be certain to give volts and amperes when the armature is rotated, assuming everything is in order and proper adjustment. The voltage given by any dynamo is in proportion to the amount of magnetism, and number of loops, or turns, of wire on the armature. With a permanent-magnet dynamo, the amount of magnetism and the number of turns of wire on the armature being constant, the

voltage given will be proportional to the speed of armature rotation. The higher the speed of driving, the higher will be the voltage. Actually, it may not come quite in proportion to the speed. The machine will work if the armature be driven in either direction, but the polarity at the brushes, or terminals, will reverse, and there may be some difference of voltage. The machine will work as a motor, if supplied with direct voltage and current, not with alternating voltage and current. The speed at which the armature will run is, approximately, in proportion to the applied voltage.

Electromagnet Dynamos

The magnetism is produced by an electric current sent through coils of wire wound around the cores, or the poles, of the field magnet. This current may be delivered from a source entirely independent of the dynamo itself. With this arrangement, the machine is termed a separately-excited dynamo. Any electro-magnet dynamo may be worked separately-excited, the magnet-winding ends being disconnected from the armature circuit, and supplied with current from a battery, or other source of direct current and voltage. Like a permanent-magnet machine, a separately-excited dynamo has advantage that it will be sure to give volts and amperes, provided everything is in working order and adjustment. The armature may be rotated in either direction, and at any speed. The amount of magnetism produced will depend upon the strength of the current (amperes) sent through the winding. There are two practical limits: the current must not be in excess of that which the gauge of wire is able to carry without becoming overheated ; the other limit is magentic—a density of magnetism in the field magnet will be reached, beyond which increase of magnetising current produces very small addition of magnetism.



To explain arrangements of various types of dynamos : A, series winding and salient magnet poles ; B, compound winding and salient poles ; C, shunt winding and internal salient poles ; D, shunt winding and consequent poles ; E, permanent magnet dynamo with pole pieces, salient poles ; F. permanent magnet dynamo with pole pieces, consequent poles. With compound winding, the series coils are frequently wound under or on top of the shunt coils.

Three other arrangements of electro-magnet dynamo are in use, termed, respectively, series, shunt, and compound wound machines. The latter is sub-divided into cumulative and differential compound winding.

Series-wound Electromagnet Dynamo

With this field-winding arrangement, the whole of the amperes being generated by the armature at any moment is used to produce the magnetism. You may enquire: " Where is the current which is to be used outside the dynamo? " The explanation is, that this current flows through the outside circuit, also. Leaving the armature from one brush, it flows around the field-magnet winding, then, leaving this, it flows into, and through, the outer circuit to the other brush ; at this, it enters the armature winding. One end of the field-magnet winding is connected to one brush, the other end is connected to one terminal of the machine. The remaining brush is connected to the remaining terminal. By this arrangement, you can identify a series-wound dynamo. As the magnetism-producing current flows, also, through the outside, useful circuit, it is necessary that the outside circuit must be of low enough resistance to permit adequate magnetising current to flow, or the dynamo cannot work. If no external circuit exists, the dynamo cannot work. Actually, there will be some critical value of external circuit resistance, above which the machine will not start working. If you happen to be trying to use a series-wound dynamo, you must adjust the external circuit by experiment, until its resistance is low enough to allow a magnetising current to flow. The series arrangement of field-magnet winding is not unusual, now, with small dynamos, but you may happen to have one and be puzzled why it does not work, though the armature is driven at a very high speed. A series-wound dynamo is not suitable for charging accumulators and electro-plating, but can be used for lighting lamps, provided the total candle-power is adjusted to suit the machine's working. It may be used for working an electric motor, and for heating wires ; in the latter instance, the resistance must be high enough not to allow excessive current to flow. The machine may be converted to shunt, or compound, by re-winding the field magnet with wire of appropriate gauge. Alternatively, the winding might be separately excited.

Shunt-wound Electromagnet Dynamos

In this system, the magnetism-producing current is diverted from the armature into a separate circuit around the field magnet. It is always small, in relation to the full current output capacity of the armature. One end of the winding is connected to one brush, the other end is connected to the remaining brush. The magnetism producing current, therefore, enters the winding from one brush, and

returns into the armature through the other brush. The dynamo will work, though no external circuit is connected to the terminals. In this respect, its working depends upon the opposite condition to that which affects working of a series-wound machine. If the resistance of the external circuit is below some critical value, the armature, as may be expressed, tries to send all of its current into the external circuit and no magnetism-producing current at all into the field-magnet circuit. The machine will not excite and work, though the armature is rotated at very high speed. This action of refusal to work may puzzle one who has a shunt-wound dynamo, seemingly in perfect order, but does not work if, say, put to drive an electric motor, charge a low-resistance accumulator, or heat a wire. To ascertain if a shunt-dynamo works, make a trial on open circuit—that is, without any wires, lamps, or a motor connected to the terminals. Connect a voltmeter; at normal speed of armature, the voltage will rise considerably above the rated volts; it will come down when you connect a load, and the armature is delivering current to that circuit.

Compound Electromagnet Dynamos

In this class of machine, a combination of series and shunt coils is wound upon the field magnet. The shunt winding predominates; you may regard the dynamo as being a shunt machine having a few turns of series winding on the field magnet in addition. There are two principal arrangements of connection; they may be regarded as giving equivalent effect. You will be able to trace the respective windings by knowledge of pure shunt and series field winding connections. One important feature is whether the series winding is intended, and is arranged, to assist or to oppose the magnetising action of the shunt winding. In the former, it is termed cumulative; in the latter, differential. Briefly, a cumulative series winding is used either to maintain even voltage at the terminals of the machine, or to produce an increase of voltage as the output of current increases. Other service is to prevent the machine losing its magnetic excitation if sudden extra current demand occurs, as when an electric motor is started, or an arc-lamp is switched on. The differential arrangement is to check rise of voltage occurring with increase of current output, or even to diminish the voltage, but, for home workshop service, is not likely to be required. The cumulative arrangement may be very useful, if the connection happens to give differential effect, may be changed over to give cumulative; in either, the series winding may be disconnected and the dynamo used as a shunt wound machine.

About Initial Magnetism

With an electro-magnet dynamo, you may wonder how the armature is able to start producing voltage with an existing field of magnetism being present. Actually, a small residue is left in the field magnet by the magnetising current, after it has been switched off. This is termed residual magnetism; it is an initial field, and is usually sufficient in amount to set up a starting voltage in the armature coils. If this starts, it will set going a current through the field magnet winding, increase of magnetism results, and so, the full amount of magnetism is built up by cumulative effect.

The Science Masters' Association

THE Thirty-eighth Annual Meeting and Exhibition of the Science Masters' Association, was held, this year, at the Imperial College of Science and Technology, South Kensington, January 4th to 7th. Owing to circumstances of the College arrangements, it coincided with the Physical Society's Exhibition, but was a quite separate affair. These Meetings and Exhibitions are held in London bi-annually. An extensive programme of discussions, lectures, and visits to works and other places of interest is arranged in connection; there was also an extensive trade Exhibition of instruments, scientific apparatus, supplies and technical publications. Peculiar to the occasion was a Members' Exhibition, principally consisting of educational and scientific demonstration and research apparatus, contrived by science teachers and made by their students in the various schools.

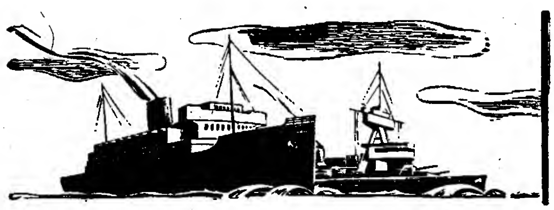
Emphasising Utility of a Workshop and Tools

We were particularly impressed in viewing this Members' Exhibition; it so well evidenced the utility which a small workshop with outfit of tools, simple lathe, vice, and so on, has, not only in model making and general work, but for enabling construction of elementary scientific educational apparatus. This is an aspect of the home workshop which, we consider, should have serious attention and consideration. There was not one, so far as we observed, of the students' exhibits—all working apparatus—which required a high grade of mechanical skill to construct, or expensive material embodied in its parts; yet, in general, they demonstrated important principles or applications.

A model of lead chamber process, for the manufacture of sulphuric acid, made by boys at the Central Secondary School, Sheffield; a working model, showing star time, and certain well known constellations, made at Stowe School; a microtome, using wafer razor-blades; model of traffic lights; a home-made sonometer; a sensitive physical balance of simple construction; a Bourdon pressure-gauge, with simple home-made tube; an electric turntable from an old spring motor; various laboratory fittings, retort stands, clamps, tripods, etc.; a variety of electrical apparatus, motors, transformers, and galvanometers; a home-constructed 5-in. Newtonian reflecting telescope.

Manufacturers' Exhibition

Many well-known makers and dealers of scientific apparatus, and technical supplies, were exhibiting in this trade section; in particular, we mention: supplies in chemicals of all kinds, Hopkin and Williams, Ltd., 16 and 17, Cross Street, Hatton Garden, London, E.C.; small engines, pumps and castings, Stuart Turner, Ltd., Henley-on-Thames; a special vacuum and pressure pump, the "Nelson," an electric motor gyroscope, with attachments for demonstrating gyroscopic action in ships, and various applications, also, educational apparatus, G. Cussons, Ltd., The Technical Works, Lower Broughton, Manchester; a wide range of physical and chemical apparatus, Philip Harris and Co. (1913), Ltd., 63, Ludgate Hill, Birmingham. Information concerning the Association, and the Exhibition, may be obtained from the Annual Meeting Secretary, Mr. R. E. Williams, 15, Norham Gardens, Oxford.



MODEL MARINE NOTES

In the Wake of the Power Boats

By THE SPECTATOR

I HAVE had queries from readers as to whether the " Simplex " engine is large enough to drive the model steam tug *Gondia*. The answer is that it is large enough, but to get best results and use a large diameter prop, it should be geared to run faster than the propeller shaft. A more suitable engine by the same makers is the vertical 3/4" bore and 3/4" stroke marine engine. The makers, by the way, are Messrs. Stuart Turner, of Henley-on-Thames. Quite clean castings are available for those who wish to do the machining themselves and if there is sufficient interest, I will endeavour to describe the machining of such a set. This machining is not nearly so complicated as many people suppose, and if the job is tackled according to the tools available, the result should be a really sturdy engine capable of sustained hard work.

Reduction Gear for Propellers

When I originally suggested that it would be preferable to gear the " Universal " engine to run faster than the prop, I did not anticipate that the actual gears and box would be any problem. Having had letters on the subject and seen one rather poor effort, I propose to leave fittings this week and describe the making of a simple gearbox which can be made from stock gears and material without the need of castings.

First, with a model such as the *Gondia,* it is a mistake to use too small a prop shaft; ¼" is a reasonable size, and will be strong enough in brass, though I prefer steel. A 5/8" diameter stern tube will allow of substantial bushes with a large grease space in between them. Some means of getting the grease into the tube should be provided, such as a motorcycle grease nipple to which a grease gun can be applied, forcing in the grease until it shows at the propeller end of the tube.

The gear reduction should not be less than two to one and I do not think three to one would be too much ; the gears must be obtained so that the centres and general measurements are available. Smith's, the metal people, of St. John's Square, stock a series of gears of 20 pitch and ¼" wide which I have found very satisfactory in use and quiet in operation if correctly meshed. Made of brass, they wear quite well and are reasonable in price. The smaller gear should have 15 teeth and the larger 30 or 40. Any other gears will do quite as well, but if of finer pitch they will require more accurate meshing.

For the case, a piece of brass of the flat screw rod variety is needed, ⅝" thick and at least ¼" wider than the largest gear and long enough to extend a similar distance beyond the outer extremes of the peripheries of the two gears when meshed together. Thick brass of this section is not usually found in the average model engineer's store ; it may be worth while to obtain six or eight inches of it.

Keying the Gears to the Shafts

The correct, and certainly the best way to fix the gears to the shafts, is to key them with small Woodruff keys 1/16" thick and 5/16" diameter. The larger gear should be fixed to the propeller shaft with about 3/16" of the latter projecting through one side. The smaller gear is attached in a similar fashion to a piece of ¼" diameter shaft, 2" long and located ⅝" from one end. In the sketch, the gears are lettered *g* and *h*, the propeller shaft *a*, the short shaft *m* and the keys *i*. The projecting end of the prop. shaft is threaded right-hand for right-hand propellers and left-hand for left-hand. This is not important as far as actually threading goes, a 1/16" hole for a split pin is quite as good. The drilling or threading of the shaft is to hold the small hardened steel cap which takes the prop. thrust, marked *j* in the sketch. It can be turned from a piece of ⅜" bright mild steel and case-hardened.

The Case

The first step is to mark off the brass for the gear centres, these being obtained by laying the gears on a flat surface with their teeth meshing and measuring the distance between the centres of the bores. To obtain free and silent running, there should be a very slight amount of play between the teeth. Next, scribe a centre line down the centre of the brass and centre pop it two thirds of the diameter of the larger wheel from one end, mark the centre of the smaller gear and centre pop that. With dividers, mark circles on the brass ⅛" larger in diameter than the gears, using the centre pops as the centres. Mark and centre punch the four holes *p*, clamp a piece of 14 or 16 gauge brass large enough to cover the finished box, under the brass bar, and drill them ; take them apart and open out the holes in the thinner brass to ⅛" and tap the holes in bar ⅛" Whitworth.

The boring of the case is done on the faceplate, and if the lathe is large enough to swing it, there is no need to cut the brass bar, as the part which will eventually be cut off serves very well to go under the straps which hold it to the faceplate. Under these circumstances, there is a good deal of weight out of balance which should be compensated for by bolting two or three of the lathe's change-wheels on the opposite side of the faceplate, to act as a counterweight. If this is not done, the lathe will be subjected to considerable strain, if run at a moderate speed, and, also, will try to walk about on its stand.

The brass bar can be roughly adjusted for position on the faceplate by running the back centre up to it and locating it in the first centre pop and then tightening the clamps lightly ; withdraw the back centre and rotate the lathe by hand and observe if the centre pop is running true—if not, it can be

lightly tapped in the correct direction until it is and then tightened up. Feed the centre drill in to its full diameter and then drill through ½″ or with the nearest to that size available. The hole is next bored out ¾″ diameter right through and counter-bored for ½″ deep to the diameter of the scribed line on the face of the material. Next, screw the plate, which is going to be the cover, into place on the brass bar and carefully centre and drill ⅜″. Remove the plate, loosen the bar on the faceplate and repeat the setting up for the recess for the smaller gear. In this one the hole which is bored right through is only ⅜″ diameter. Replace the cover plate and again carefully centre and drill ⅜″. Without removing it from the brass bar, the cover plate can be marked out with the profile of the box as indicated on the sketch, and the two cut out and filed up together. These two parts are the gearbox and cover, this last being marked *s* on the sketch.

Bushes

The bush marked *e* is bored to a good fit on the outside of the stern tube *b*, and shouldered down to

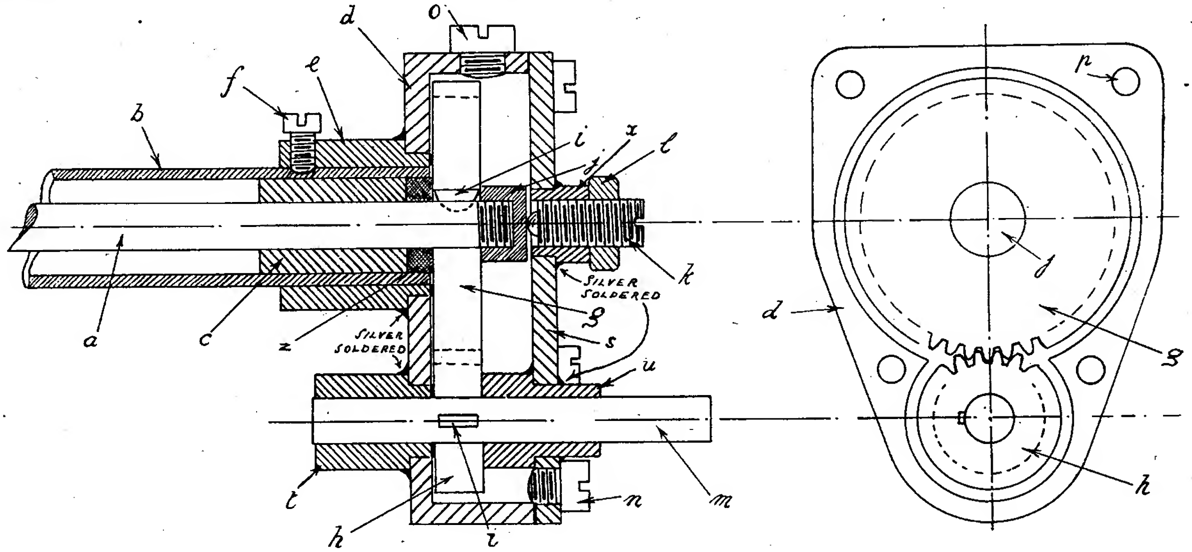
tapped ¼″ by 26, a grease nipple can be screwed in for charging the box with grease.

The thrust screw *k* can be an ordinary screw drilled in the end for a ⅛″ ball-bearing, which is fixed by burring over the edge of its recess with a small chisel or centre punch. The thrust screw is adjusted so that there is just a slight play in the prop. shaft and then locked up with the nut *l*.

The bush *c* is pressed into the stern tube to ⅛″ below its edge, the space left being filled with the felt washer *z*, which acts as a gland. The felt washer can be punched out with wad punches if they are available or with brass tube which has been given a knife edge in the lathe. The felt should be thick enough to stand clear of the inside of the box and will make the shaft run tight for the first few hundred revolutions, after which it will work to an easy fit.

Connection to Engine

The projecting end of the smaller shaft can be coupled to the engine in the normal way, but better by a further short shaft and ball and socket joints at each end.



Section of reduction gear for reducing propeller speed, and, on right, view of box and gears with cover removed.

press into the larger hole in the gearbox ; it should be not less than 7/8″ diameter outside to allow enough metal for the thread for the setscrew *f* which fixes it. Bushes *t* and *u* are machined from ½″ rod and reamed ¼″, while bush *x* is drilled and tapped ¼″ Whitworth or 0 B.A. Note that bushes *e* and *t* project slightly through into the inside of the box, so that the gears will not rub all over.

Having got the bushes in place, it is as well to assemble the box complete and make sure that the gears rotate freely, and then silver-solder the bushes in place. This will be easy enough as far as the cover is concerned but care will be necessary when dealing with the box, as the metal being rather heavy, the bushes will tend to get too hot before the silver-solder runs ; concentrate the flame on the edges of the box first and don't be in too much of a hurry to reach running temperature.

¼″ holes can now be drilled and tapped for the drain plug *n* and the filling plug *o* ; if this last is

The set screw *f* should be recessed into the stern tube—it takes the prop. thrust.

As there is a tendency for the power to turn the gearbox, it should be fitted with a strap anchored under one of the cover screws and attached to the hull, to act as a torque stay.

After some use, water may find its way into the box and should be drained out at the end of a day's running by removing the plug *n* and then refilling with grease.

The cutting of small keyways was described in these notes in the issue of November 12, 1936.

The joint between cover and box should be made with paper and goldsize, which makes it quite tight.

Just one more point: please don't write and tell me that the gearbox can be made to pump out any water which gets in or even act as a bilge pump. A small quantity of water will do no harm but if made as a pump it will soon get rid of its lubricant, which is not so good.

Practical Letters from our Readers

Finding the Engineers of the Future

DEAR SIR,—I have read, with interest, the article in your issue of February 10th, called "Finding the Engineers of the Future." It occurs to me that some of your readers might like to have further details concerning our vocational guidance service.

The boys and girls who come to us for advice are, usually, between the ages of 16 and 19. Since, normally, the temperamental qualities—which are of such importance in the choice of a career—develop considerably up to the age of 16, it is not easy to give very definite advice before that age. Consultations may be arranged at the Institute's headquarters in London, at the offices of its Scottish Division in Glasgow, or at its North-Western Area offices in Manchester. Consultations are normally arranged at 10 a.m. and 2 p.m., and last about two-and-a-half hours.

The Institute always advocates the collection of as much information concerning the boy or girl as is possible. It accordingly issues record forms for the parent to complete, and usually, also, forms on which the schoolmaster can record information concerning the school career. The Institute supplements this information by the use of a series of standardised psychological tests, and by an interview conducted along special lines. After the consultation, a report is prepared and sent to the parent, in which the boy's or girl's talents and temperaments are discussed and a number of vocational possibilities put forward. The fee for the normal consultation is three guineas. In what may be termed "problem cases," a lengthier consultation is given, for which the fee is five guineas.

Contrary to what might be expected, only a small number of those advised by the Institute present abnormalities of intelligence or temperament. The majority are perfectly normal young people, some of whom have quite clear ideas as to the career they wish to follow, but who are anxious that their own ideas should be confirmed after a thorough review of the problem. The larger number, however, have little or no idea of the occupation for which they are best suited.

I should be very pleased to send further details of our work to any of your readers who may be interested.

Yours faithfully,

C. B. FRISBY, *Secretary,*
National Institute of Industrial Psychology.
Aldwych House, Aldwych, W.C.2.

Four-Cylinder 4-6-0 Locomotives

DEAR SIR,—Having read, with interest, the letters on the subject of the L.S.W.R. four-cylinder 4-6-0 locomotives, I should like to hear readers' views on another type of four-cylinder locomotive which does not seem to have been a popular success—namely, the "Lord Farringdon" class on the late Great Central Railway. These fine-looking machines have been tried on various services, under L.N.E.R. auspices, and some of those which have not been re-built with Caprotti valves have been employed, of late, on secondary and third-rate trains in and about North Lincolnshire, whilst they are very similar, in general dimensions, and ought to be as good as, the "Sandringham" class L.N.E.R. engines of Sir Nigel Gresley's design.

I have studied the design of these engines and compared them with other types of similar size, and, naturally, have drawn my own conclusions.

Generally speaking, enginemen say that the engines burn too much coal, and that this is due to the front-end design being at fault, but I have not heard an engineman say anything against the boiler itself—which, in my opinion, is the main part at fault, though I do not dispute that the cylinders, steam-chests, and distribution could be greatly improved on these engines. Nevertheless, I think that, were it possible for one of these engines to be taken in hand by, say, the Great Western authorities, and let them fit cylinders and valve-gear to work like their four-cylinder engines, they would not then be everything that could be desired, as the boilers would let them down on a hard run, such as is found on the old Great Central main line.

The boiler, on these engines, has a huge barrel 17 ft. 7⅜ in. between tube-plates, and 5 ft. 6 in. diameter, with the modest grate area of 26 sq. ft. This grate area is the same as on the "Director" class of 4-4-0 engines, but the "Directors" have a barrel only 11 ft. 4⅜ in. between tube-plates, and slightly less in diameter. On looking at it from this angle, it occurs to me that the fault is, as your worthy contributor, "L.B.S.C.," has often said, "that it is no good having a large water space if there is not enough fire to heat the water efficiently."

Now, some years ago, the L.N.E.R. engineers re-built two of these engines, with Caprotti valves and gear, and, after modifications had been carried out, I believe the results were much better than formerly, as regards coal consumption, but I fail to see, even then, how the performance could be entirely satisfactory with the original type of boiler.

I have often wondered what was in the minds of the designers, when these engines were built, and can only think that, in those days, it was intended to use only the best steam coal obtainable; but, perhaps, someone could enlighten me on the subject?

Yours truly,

Lincoln. D. H. YARNELL.

Flash Steam Pumps

DEAR SIR,—In the February 17th issue of THE MODEL ENGINEER, I read, with interest, "Spectator's" remarks on flash steam pumps. He mentions a type of pump which has been known, for many years, as the differential pump. He seems to consider it difficult to get the ratio of the diameters reasonably correct; I am surprised that anyone could see any difficulty in this, it being very obvious that the area ratio is 2:1, the piston-rod

being half the area of the cylinder or pump barrel.

I also note that this is not unknown in heavy oil engine fuel-pumps. I have not come across it, in this respect, but have seen a great many feed-pumps with it. Also, it was a very common type, at one time, for high-pressure hydraulic pumps, and, I believe, was introduced by the late Lord Armstrong. There are many hydraulic pumps of this type working at docks to-day, the last one I saw being at Goole, last October. Messrs. G. & J. Weir (who are the largest firm of their kind in Europe—and, I believe, in the world—manufacturing feed-pumps and accessories) took out a patent, in 1881 or 1882, for a boiler feed-pump, and the illustration shows and describes this differential type, although I do not think they were claiming originality for it, but I do know they made these pumps in large quantities for boiler feeding. The last one I saw was in a valve manufacturer's, in Glasgow, for feeding their test boiler. This pump was replaced, shortly after the war.

The main reason why the manufacture of this type was abandoned, was the very large piston-rod necessary, which absorbed too much power at the stuffing-box.

There is another point in " Spectator's " remarks with which I do not agree. He mentions that water does not compress very much. I have been taught, for a good many years, that water is incompressible, and, although it is not exactly so, it is near enough for all practical purposes ; but oil, as used in Diesel engines, is compressible, very much more so than water. I am not just sure of the figure, but, I believe, it is very nearly about 3 per cent. ; but here, again, it is not worth taking into account.

Yours truly,

Glasgow. " PUMP."

Tool-Room Topics

DEAR SIR,—Firstly, may I say " thank you " for the interesting and instructive articles you have published, under the title of " Tool-room Topics "? To anybody who has had to spend a lot of time among the kind of chaps who deal in full eighths and bare sixteenths, the account of how accurate work should be done—and, particularly, the advice about how accuracy may be initiated—is very valuable.

Secondly, may I point out a warning which Mr. Hutcheson overlooked, in the article on " Hardening the Die," in the issue of August 19th? I refer to the importance of tempering as soon as possible, after hardening. I have seen many cases of cracked dies (and other objects) from this cause ; it commonly happens that a tool is hardened at the end of the day, and tempering is postponed till next day ; or that the tool-hardener, from motives of economy or convenience, accumulates a batch of work to be tempered. Naturally, the hazard increases with the size of the job, and the intensity of hardening, but the only safe rule is not to harden unless, or until, time and facilities are available for immediate tempering.

Thirdly, regarding the " sine-bar " article, in the issue of November 4th. I would like to suggest that the most satisfactory method of obtaining soft places, on case-hardened work, is to machine away the "case" after carburising, and before quenching. Clay-plugging is treacherous, as the clay is liable to crack and allow the gas evolved by the carburising mixture to reach the places where it is not wanted, and carburising is done by the gases evolved, not as is commonly supposed by contact with the charcoal, etc. Similarly, asbestos pads are not sufficiently impervious to be reliable, and copper plating should be electro-plated, and well carried out if disappointment is to be avoided.

In the case of the sine-bar, I would suggest that a more satisfactory procedure would be to drill the holes after the sine-bar has been carburised, but not quenched. In order to be able to bore the holes in the finished bar, it would be necessary to chamfer the holes to an extent depending on the depth of the " case." After the holes had been drilled and chamfered, the sine-bar should be heated to the hardening temperature, and quenched ; an incidental benefit of re-heating for the final quench would be gained in a reduced brittleness.

Thanks, again, to you and to Mr. Hutcheson.

Yours truly,

Sandringham, Australia. LEO BREARLEY.

Governor for "Sandhurst" Petrol Engine

DEAR SIR,—I have nearly completed building one of Messrs. Stuart Turner's " Sandhurst " petrol engines, and should like to fit a governor. Can any reader kindly supply me with a design, or any helpful information?

Yours truly,

Strathaven. C. H. HUGHES.

Noiseless Belting

DEAR SIR,—With reference to the letter, on page 23 of THE MODEL ENGINEER of January 6th, 1938, concerning " Noisy Belt Fasteners." I wish to suggest a method for fastening belts, so that they will be noiseless in operation. The following cement may be made by anyone quite easily. Dissolve good cabinet-makers' glue, one part, in water, four parts, using a double-boiler gluepot. Care must be taken not to overheat the glue. In a separate container, dissolve tannic acid, one part, in water, ten parts. Add a few drops of glycerine, to help dissolve the tannic acid. This last solution is heated and added to the glue, and the combined solution heated until stringy. To use the cement, bevel the ends of the belt and roughen them with a file. Warm the prepared belt-ends and apply the cement with a brush. As soon as possible, apply pressure to the splice by clamping it in a vice between two pieces of wood. The splice should be left clamped for forty-eight hours before it is put into service. I might suggest that, when splicing leather belts, the splice should be as long as the width of the belt, or longer, if desired.

Yours truly,

Dersley, S.A. B. RUSSET HARRIS.

Model Boating Ponds

DEAR SIR,—With reference to Mr. Boomer's letter, in your issue of the 17th inst., some clients of mine, a local authority, are now out to tender for the construction of a large model yacht pond, which will be of ample size for the largest types of racing model. I am not at liberty, at present, to give any particulars, but, as soon as the contract is let, I hope to be able to give some of the details for the delectation of any of your interested readers.

The construction of the pond forms part of a larger undertaking of reclamation of land and the construction of bowling greens, hard tennis courts, etc., on all of which a considerable sum of money is to be spent.

Yours faithfully,

Westminster. H. J. DEANE.

Power Boat Racing on a Straight Course

DEAR SIR,—In reply to J. H. Denham's letter, appearing in the "M.E." of January 27th, where he suggests racing boats in heats on a straight course, I have for years been advocating this type of racing. The main difficulty is that there are so many different types of boats, and also one requires a lot of support, such as efficient stoppers. Boats must also be absolutely reliable and reasonably straight running. I have tried it out with fellow enthusiasts, notably Mr. Vanner, and can vouch for more excitement and sport than running on the circular course. The boats used were cabin cruisers, metre long, with 30 c.c. engines of low compression, giving very steady and straight running. The speeds were up to about 15 m.p.h., approaching the limit for the stoppers, who were in waders.

Mr. Denham's idea of using small capacity engines is very good, as it tends to keep the speed down, although, no doubt, in time this would creep beyond the safety limits. I think the time switch would be rather a gamble, and an added complication, and would only have to fail once, to put paid to a boat's career.

I would like to augment Mr. Denham's suggestion; that, perhaps, THE MODEL ENGINEER could draw up suitable plans of a boat for this type of racing, hull, say, about three feet long and narrow beam, engine up to 6 c.c. capacity.

If the hull is considered on the long side, my contention is that a short boat gives the general public (from which future members are drawn) a bad impression. A long narrow boat can be very pleasing to the eye, as anyone who has seen Mr. Vine's *Silver Bullet* will agree. Finally, in my opinion, if Mr. Denham's and my own suggestions were tried out it would give the sport a much-needed fillip, and bring fresh support to the ranks of model power boat enthusiasts.

Yours truly,
G. A. WALKER,
Carshalton. S.L.E. & P.B. Club.

Institutions and Societies

The Society of Model and Experimental Engineers

The next meeting will be held at the Caxton Hall, Westminster, on Thursday, March 24th, 1938, when Mr. Geoffrey Parr will give a lecture entitled "Television Developments." Mr. Parr is the Lecture Secretary of the Television Society, and a recognised expert on this subject. The first portion of the lecture will be illustrated by lantern slides, and will be followed by a demonstration on the 9 o'clock programme.

Non-members will be admitted by ticket only, which may be obtained on application to the Secretary, H. V. STEELE, 14, Ross Road, London, S.E.25.

The Romford Model Engineering Club

At the Romford Model Engineering Club's meeting, held on February 17th, at the Red Triangle headquarters, representatives of the British Oxygen Company attended and gave a demonstration of the different brazing and welding processes, using both oxy-acetylene and oxy-coal gas outfits. As the new workshop of the Club has the latter installed, the assembled members were, naturally, more interested in the methods employed for oxy-coal gas, and an interesting discussion took place, which included some very technical dissertations. The Club would like to place on record its sincere thanks to the British Oxygen Company for sending it such able and courteous representatives.

With the opening of the workshop in the very near future, and the resumption of track work, etc., the members are looking forward to a very active summer season. The Club is well served, with plenty of room, including a 400 ft. track, for its many activities, and new members will be cordially welcomed. Meetings are held on the first and third Thursdays in each month.

The Hon. Secretary's address is: W. J. CLOGG, 9, Shirley Gardens, Hornchurch.

Wigan and District Model Engineering Society

The next meeting will be held in Lee's Café, on March 15th, at 7 p.m.

Hon. Secretary, JOHN L. WATERHOUSE. 227, Downall Green Road, Bryn, Wigan.

The Daventry Model Engineers' Society

The following lectures will be given by Mr. H. J. Harratt, in the Society's club-room, Oxford Street, Daventry: Thursday, March 17th, "Design and Drawing"; March 24th, "Pattern Making Practice"; March 31st, "Foundry Practice."

Hon. Secretary, H. J. HARRATT, 12, The Inlands, Daventry.

The Junior Institution of Engineers

Friday, March 11th, 1938. At 39, Victoria Street, S.W.1, at 7.30 p.m. Ordinary meeting. Paper: "Canal Locks and Other Lifting Devices in Inland Navigation," by D. G. McGarey, B.Sc. (Eng.), Assoc.M.Inst.C.E. Slides.

NOTICES

The Editor invites correspondence and original contributions on all small power engineering and electrical subjects. Matter intended for publication should be clearly written on one side of the paper only, and should invariably bear the sender's name and address. Unless remuneration is specially asked for, it will be assumed that the contribution is offered in the general interest. All MSS. should be accompanied by a stamped envelope addressed for return in the event of rejection. Readers desiring to see the Editor personally can only do so by making an appointment in advance.

All subscriptions and correspondence relating to sales of the paper and books to be addressed to Percival Marshall and Co., Ltd., 13-16, Fisher Street, London, W.C.1. Annual Subscription, £1 1s. 8d., post free, to all parts of the world. Half-yearly bound volumes, 11s. 9d., post free.

All correspondence relating to advertisements and deposits to be addressed to THE ADVERTISEMENT MANAGER, "The Model Engineer," 13-16, Fisher Street, W.C.1.

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The asterisk [*] denotes that the subject is illustrated